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SPECIAL REPORT: **GROUND SUPPORT ENGINEERING**



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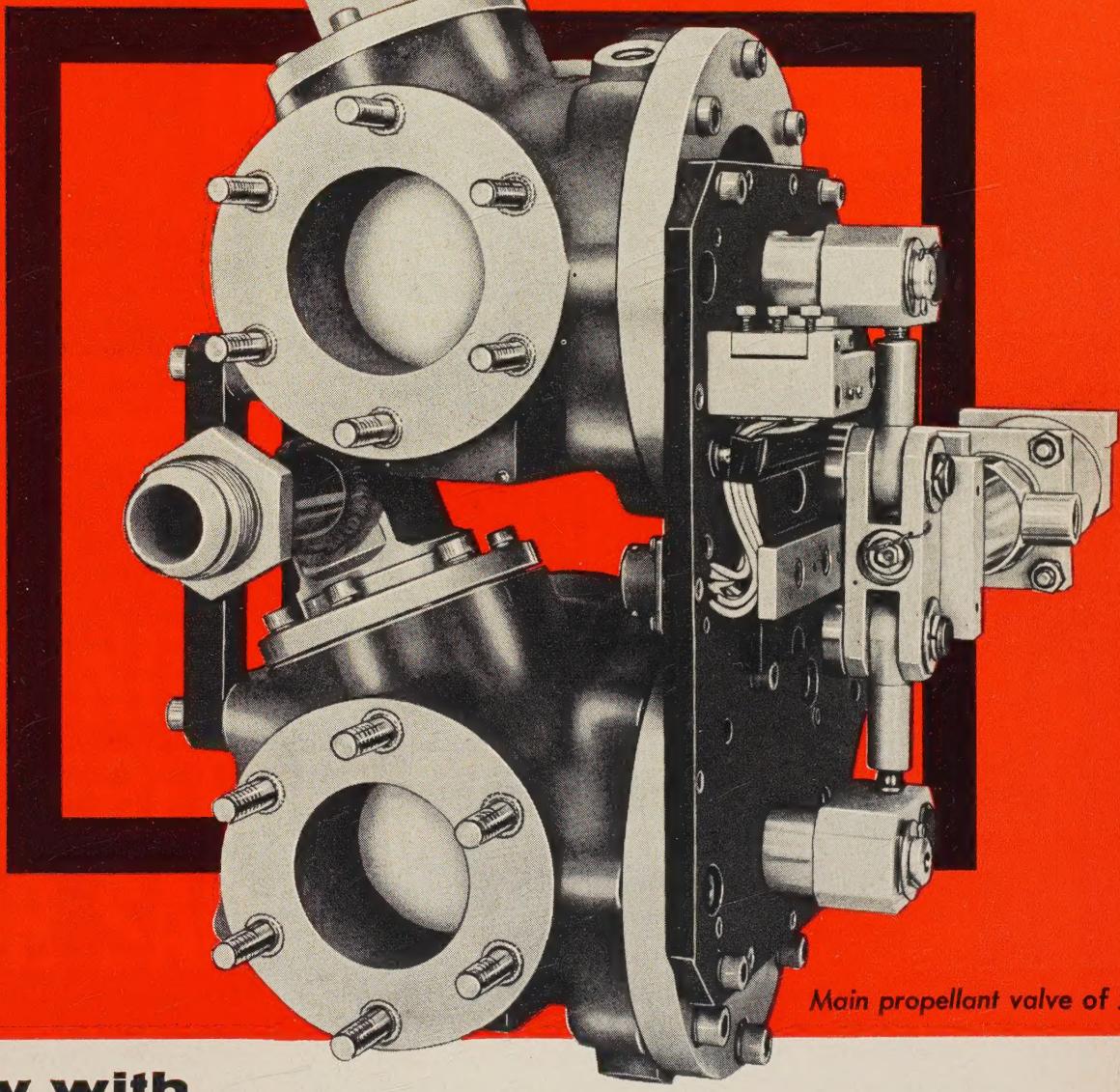
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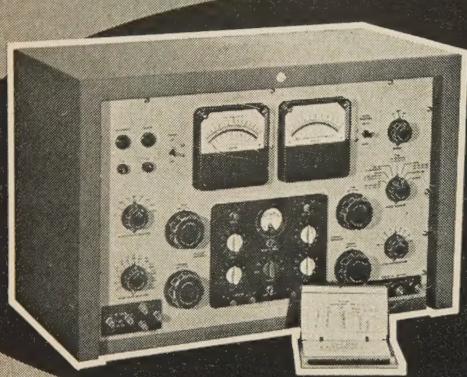
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**cover story**



SPECIAL REPORT: GROUND SUPPORT ENGINEERING

A CONOVER-MAST PUBLICATION

GSE did its job in this conception by artist George Meyerriecks of the instant after a missile launching. To find out how well GSE is doing its job in reality, turn to this issue's special report on Ground Support Engineering, beginning on page 49. This special report features an overall review of the current state of the GSE art and the outlook for the future, staff-written surveys on the problems of GSE-weapon system integration and of electronic GSE, articles by experts on such crucial GSE developments as hardened bases and nuclear servicing, and two extensive listings giving details on the industry's current GSE activities and capabilities.

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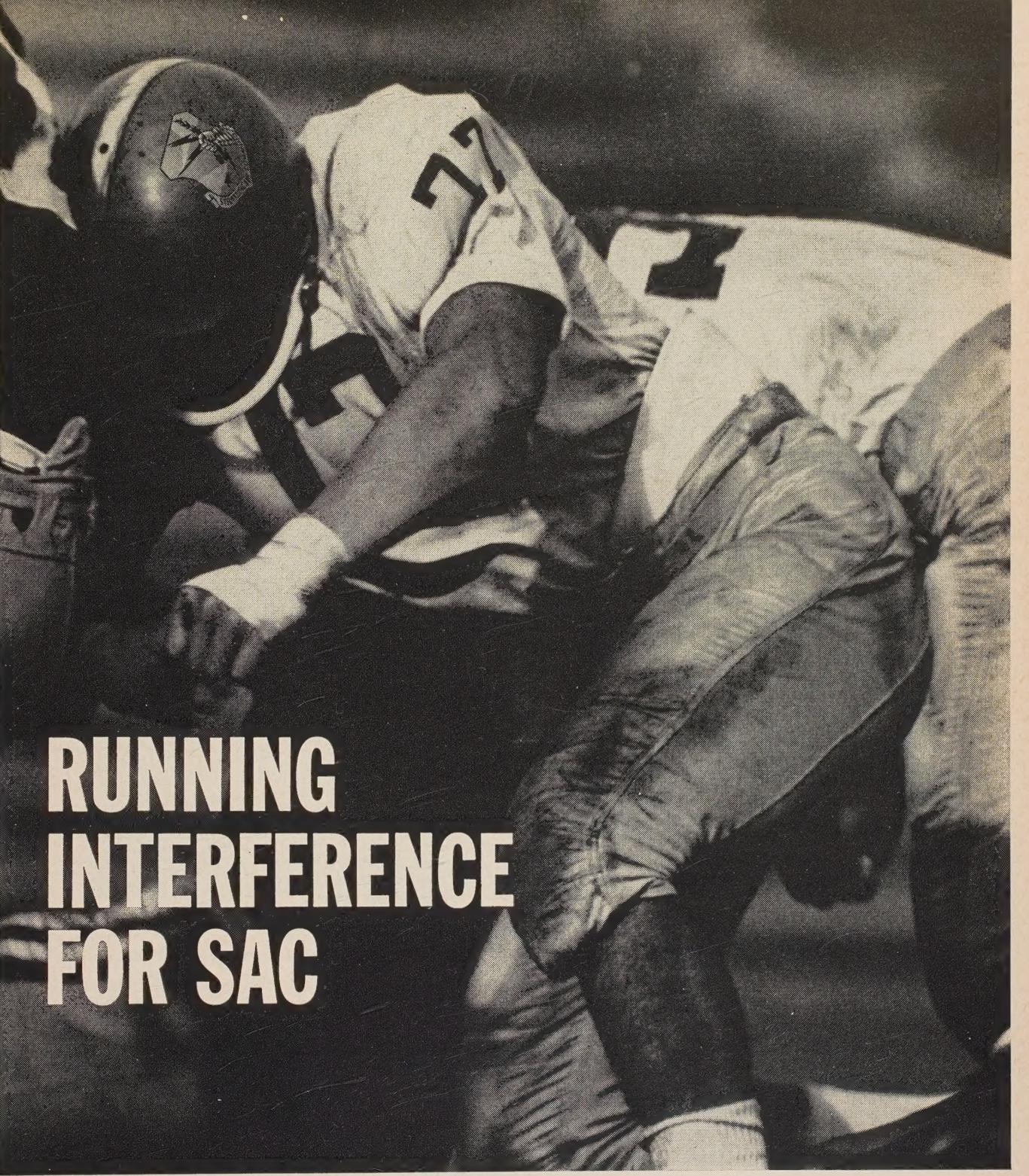
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The Missile Division of North American Aviation is weapon system contractor for the GAM-77.

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## Special Report: GROUND SUPPORT ENGINEERING

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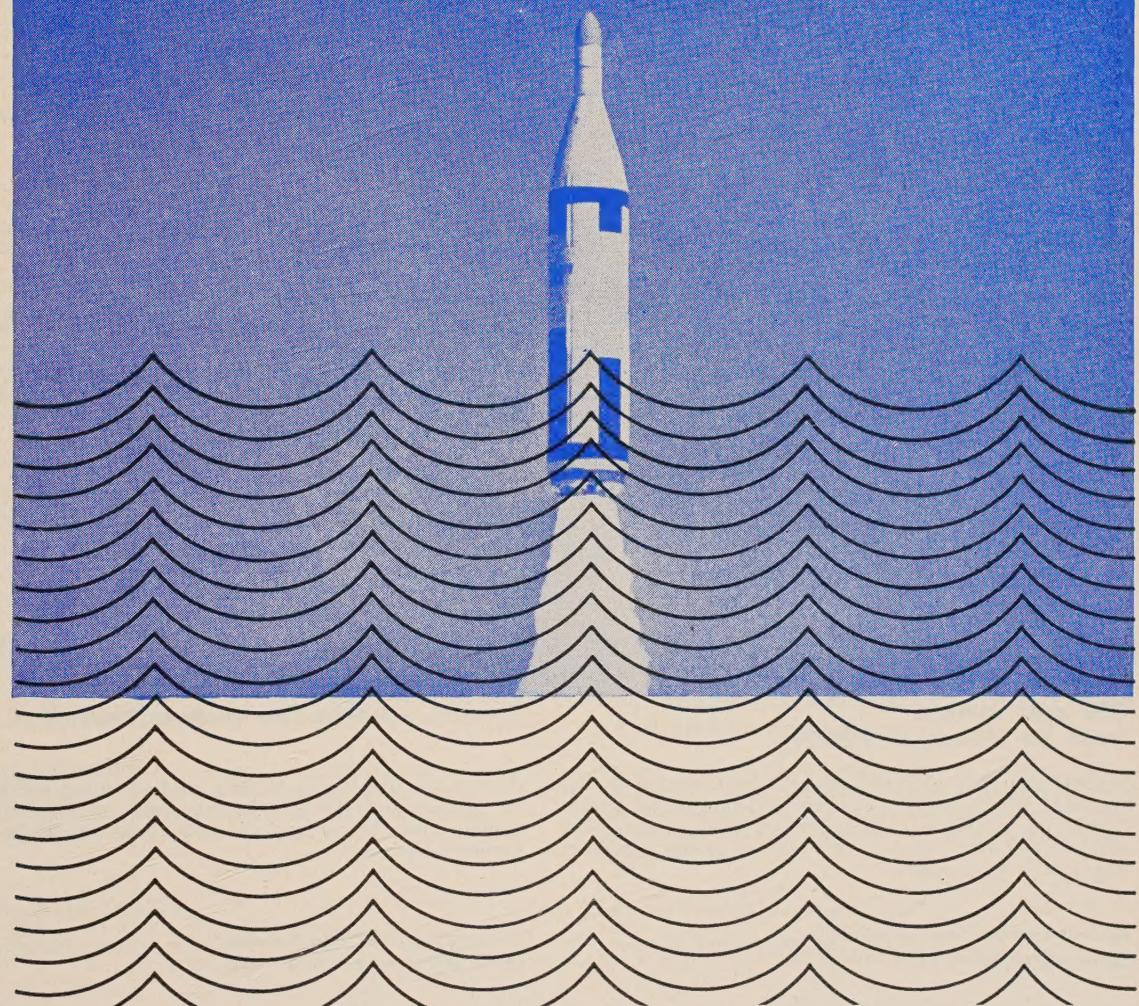
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The editorial content of Space/Aeronautics is regularly examined for readability by Robert Gunning Assoc., consultants in clear writing. These consultants meet periodically with the editors and discuss comparative readability ratings.

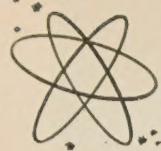


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# in this issue

Here's a quick rundown of the technical information offered in the articles in this issue. You can also use these article abstracts to build up your own permanent record for reference in the future—just clip them, paste them up on standard three-by-five cards, and file them.

Special Report:  
Ground Support Engineering

Astia code: 1-4; 12-3  
Your code:

## Ground support engineering seeking true design yardstick

Review of current state of the art in and outlook for GSE. Problems of producer-user relationship are analyzed, trends to universal, independent, and advanced GSE are reviewed, and design problems of hardened bases and mobile ICBM, nuclear, and spacecraft GSE are summarized.

by Victor de Biasi, Associate Editor & Project Leader  
*space/aeronautics* 32/4 (Oct. '59)

p. 49

Special Report:  
Ground Support Engineering

Astia code: 1-4; 12-3  
Your code:

## How the military funds and programs GSE

Discussion of problems of GSE funding control in defense budget and detailed breakdowns of GSE allocations of the three services. Air Force's attempts at GSE standardization are highlighted.

by Robert M. Loebelson, Associate Editor  
*space/aeronautics* 32/4 (Oct. '59)

p. 54

Special Report:  
Ground Support Engineering

Astia code: 1-2, -4; 12-1, -3, -4  
Your code:

## GSE and vehicle must be closely integrated

Survey of trends and current practices relating to the effects of ground support equipment design on the design of missiles and aircraft. Examples are given to show why GSE factors must now be considered in the very first stages of new designs.

by Irwin Stambler, Associate Editor  
*space/aeronautics* 32/4 (Oct. '59)

p. 56

Special Report:  
Ground Support Engineering

Astia code: 12-3  
Your code:

## Railway launching for mobile ICBMs

Design analysis of an inexpensive, lightweight railway launcher for ICBMs weighing 100,000 lb or more. Basic components of the launching car are described and the launching cycle steps are outlined.

by Michael L. Mastracci, American Machine & Foundry  
*space/aeronautics* 32/4 (Oct. '59)

p. 59

Special Report:  
Ground Support Engineering

Astia code: 12-3  
Your code:

## Shock-proofing for hardened bases

Analysis of vibration and acceleration levels that hardened-base equipment is subjected to and how they are affected by sandy soil or rock formations. Discusses development of shock curves by means of field test and lab data, and presents chart of general shock spectra for design use.

by E. G. Fischer & H. H. Gray, Westinghouse Electric  
*space/aeronautics* 32/4 (Oct. '59)

p. 62

Special Report:  
Ground Support Engineering

Astia code: 12-3  
Your code:

## Launcher-transporter highlights simplicity of Thor GSE (Design Progress)

Design details of launch mount and transporter-erector for Thor IRBM. Diagrams show construction of launching legs, semi-trailer-to-launch-mount connections, semi-trailer assembly, and umbilical installation.

by Irwin Stambler, Associate Editor  
*space/aeronautics* 32/4 (Oct. '59)

p. 66

Special Report:  
Ground Support Engineering

Astia code: 1-4; 21-7  
Your code:

## Ground support for nuclear aircraft

Discussions of ground landing and servicing techniques for nuclear aircraft? Details are given on handling, refueling, and cooling systems as well as on tenders for nuclear seaplanes.

by Harry L. Loats, Flight Refueling  
*space/aeronautics* 32/4 (Oct. '59)

p. 69

Special Report:  
Ground Support Engineering

Astia code: 1-4; 12-3  
Your code:

## GSE company capabilities (list)

Extensive listing of GSE specialties of aerospace companies, based on a survey of over 1500 firms. Where applicable, recent GSE contracts are noted and literature on GSE capabilities is offered.

*space/aeronautics* 32/4 (Oct. '59)

p. 93

To make filing easier, each abstract is coded according to the Astia Distribution Guide. Copies of this guide are available from Armed Services Technical Information Agency, Arlington Hall Sta., Arlington 12, Va. There is also room on the abstracts for you to insert your own key if you use a special coding system.

Aerospace Engineering  
Accessory Systems

Astia code: 7-1  
Your code:

### Batteries challenge hot-gas systems for APU applications

Description of simple, reliable automatically activated silver-zinc batteries that have replaced hot-gas turbine systems as APU power sources in some major missile programs. Diagrams of several battery APU systems are included.

by W. A. Fischer & J. A. Sibilia, Cook Batteries  
space/aeronautics 32/4 (Oct. '59)

p. 146

Aerospace Engineering  
Systems Engineering, Dynamics, Structures

Astia code: 1-2  
Your code:

### Deflected slipstream gives good VTOL capabilities

Discussion of design features of Ryan Vertiplane test vehicle, built to study VTOL by deflected slipstream. Sketches of wing flap installations and three-views are included.

by Irwin Stambler, Associate Editor  
space/aeronautics 32/4 (Oct. '59)

p. 150

Aerospace Engineering  
Production Engineering

Astia code: 26-1  
Your code:

### Brazing high temperature assemblies

Analysis of procedures used in controlled-atmosphere brazing of jet engine diffuser. Details of preparatory processing are given and methods for insuring close dimensional control are explained.

by R. L. Peaslee, Wall Colmonoy  
space/aeronautics 32/4 (Oct. '59)

p. 155

Aerospace Engineering  
Accessory Components, Production  
Engineering

Astia code: 7-3  
Your code:

### New inserts, terminations, contacts for high performance connectors

Survey of design features of new crimp-type, snap-in connectors with silicone inserts for operation at high temperatures and altitudes. Assembly procedure is explained and shown in photographs. Advanced developmental connectors are described.

by Sid Marshack, Deutsch  
space/aeronautics 32/4 (Oct. '59)

p. 163

Aerospace Electronics

Astia code: 8-3  
Your code:

### Waveform design for tomorrow's radars

Explanation of matched-filter approach to getting optimum range and velocity information from target echoes. Ground rules for "ideal" waveform selection are given and two types of signal coding described. Formulas and contour drawings are included.

by Sidney Applebaum & P. W. Howells, General Electric

space/aeronautics 32/4 (Oct. '59)

p. 186

Aerospace Electronics

Astia code: 19-4  
Your code:

### Simplified dynamics for easier inertial design

Analysis of dynamics of inertial guidance system. Leveling-alignment and navigation modes are examined. Error responses in measuring direction of local gravitational vector with prime disturbance inputs are derived.

by Bernard Lee, Emerson-Electric Mfg.

space/aeronautics 32/4 (Oct. '59)

p. 191

Special Report:  
Ground Support Engineering—Electronics

Astia code: 1-4; 12-3  
Your code:

### Cost limits automation of checkout equipment

Present state-of-the-art automatic checkout test sets are described in general and by specific examples (Nortronics Datico, Autonetics GS-1A, Convair-Pomona factory production test set). Problems, trends and future systems are discussed.

by James Holahan, Electronics Editor

space/aeronautics 32/4 (Oct. '59)

p. 196

Special Report:  
Ground Support Engineering—Electronics

Astia code: 1-4; 12-3  
Your code:

### Scate: flexible universal checkout (Design Digest)

Design analysis of modular, digital, automatic checkout system based on combination of generalized and unique functions. Detailed functional diagram shows how system works with missiles, aircraft, and ground radar. Overall system block diagram, multi-circuit switching, and programmable microwave generator are shown.

by Bernard Kovit, Associate Electronics Editor

space/aeronautics 32/4 (Oct. '59)

p. 201

continued on page 13



## He took Bomarc off in a crosswind

This AMF engineer's design problem: a launcher to hold the bird on its pad in a 60-mile gale, let go on firing, *not* let go on misfiring.

His solution: Four aluminum arms, each a stubby 3-feet long, that clasp 40-foot Bomarc around its tail. Unlike systems that release during countdown, whether or not the bird goes, this system releases only on a positive, upward movement that actuates a valve in the pad. But, because all mechanical devices can fail, an emergency release system was also needed...

So, he put a small lever at the end of each arm. This lever makes actual contact with the bird. As Bomarc moves up, these levers rotate with it. After an inch of movement, they automatically snap the arms out of the way if the basic system has not already done so. Even in a wind that causes violent lateral movement, Bomarc won't get bumped. Simple, sure...imaginative.

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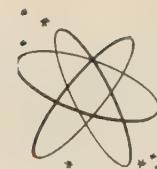
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# in this issue

continued from page 11



Special Report:  
Ground Support Engineering—Electronics

Astia code: 1-4; 12-3  
Your code:

## Patchboard programs checkout of Jupiter guidance

Design features of patchboard-programmed automatic go-no-go checker for third-echelon maintenance of two stable platform and four distributor units on Jupiter. Some of the advantages of this method of program storage are pointed out.

by Emanuel Schnall, Du Mont Labs.  
*space/aeronautics* 32/4 (Oct. '59)

p. 205

## coming next month

**ANOTHER SPECIAL REPORT** is coming up—on "Production and Materials Engineering". Like all *SPACE/AERONAUTICS*' special reports, it will start with an overall review of the outstanding management problems and engineering trends. Among the points to be taken up in greater detail in specific articles are new machine tools and machining methods, the state of the art in forming and joining techniques, the progress of numerical control, and the latest materials developments. In the electronic section of the report, the special problems of producing electronic equipment will be discussed as well as the latest thermo electric materials. In addition, there will be extensive reference material in the form of tables and graphs.

**IF YOUR DESIGN WORK** gets you involved with aerial cameras, how much should you know about them? This question, which has baffled quite a few engineers in the aerospace industry, will be answered by an aerial-photography expert, who will also outline the basic parameters of camera installation without which you cannot get along.

## coming soon

**SPACE/AERONAUTICS'** GSE coverage naturally isn't going to flag even after this month's special effort. In fact, another special treat is coming up: An extensive design analysis of what is commonly acknowledged to be the most advanced mobile missile GSE system. (The material for it was cleared through security too late for inclusion in this issue's special report.)

Aerospace Electronics

Astia code: 8-2  
Your code:

## What's ahead for junction transistors?

Analysis of design trends for PN junction transistors. Life, cost, and overall performance factors are discussed. Transistor and diode production are predicted for mid-60's.

by J. J. Ebers, Bell Telephone Labs.  
*space/aeronautics* 32/4 (Oct. '59)

p. 217

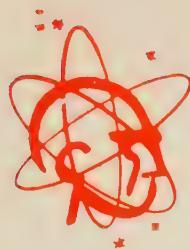
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## keeping in touch

### Metric vs English system bout in Detroit

THE RELATIVE merits of inch-pound vs metric units for U.S. industry will get a working-over at the 10th National Conference on Standards in Detroit this month on the 22nd.

All who have a vital interest "for" or "against" the American industry's converting to the metric system had better be present at the Sheraton-Cadillac Hotel event staged by the American Standards Association's Company Member Conference. The panel discussion will be followed by questions from the floor. Indications are that the "cons" on the panel will be "well supported from the floor," in the view of the program committee chairman.

As reported last month in this space, SPACE/AERONAUTICS' Editor, Randolph Hawthorne, will be a panel member speaking for conversion to the metric. Apparently, his survey questionnaire in our May 1959 issue, and editorials earlier, played a part in bringing the subject to a "point of great interest," so that the discussion was placed on the Conference agenda "to probe the depth of actual interest in the subject" of the industry's going metric.

Our Editor reports that of the 671 returns tabulated on the survey, 94 per cent favored conversion to the metric system throughout the aerospace industry. Only six per cent were against the change.

Surprisingly, he points out, readers in the production field scored the highest percentage favoring the metric system: 97 to three.

While the SPACE/AERONAUTICS survey can by no means be called definitive, it does cut across all fields of professional activity in the aerospace industry. Covering scores of firms and research institutions all over the country, big and small, it gives a remarkable cross-section of opinion.

While as large a majority as indicated by the survey may want a changeover to the metric units of measurement, it will take more than a small survey to get you what you want. Those interested, on one side or the other, can make their needs felt by filling in the form at the bottom of this page and mailing it to Mr. K. G. Ellsworth, American Standards Association, in New York City.

Meanwhile, Randy Hawthorne will help start the ball rolling for you in Detroit. Spearhead of the opposition to the metric system in the past has been the American Society of Mechanical Engineers. It just managed to stop a bill in Congress for the metric system back in 1902. Maybe this time you can write a different ending to the story. It's your fight.

Publisher

#### Metric vs English System Ballot

Mr. K. G. Ellsworth  
American Standards Association, Inc.  
70 E. 45th Street  
New York 17, N. Y.

Dear Mr. Ellsworth:

I wish to recommend that American industry convert to the metric system . . . . .

I wish to recommend that American industry continue with English system units . . . . .

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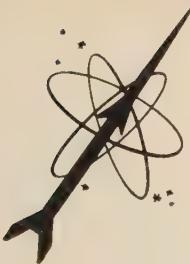


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SPACE/AERONAUTICS



## editorial

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### Fog and irritation in the GSE field

**Q**UIITE A BIT of irritation and "fog" cover the ground support equipment field. Our special report in this issue tries to burn some of it away. For instance, GSE project leader Vic de Biasi, spearhead of our report, finds that the men using the equipment are extremely unhappy. They think the industry is less interested in efficient, economic, simple design than it is in profits. The equipment is too complex. It is over-designed. It doesn't work well in the field.

These are hard words. The weapon systems contractors may not like them. But let them stop and consider that—right or wrong—it is what their customer thinks. This thinking has grown from irritation to bitterness as time and experience go on. It first was revealed in our GSE report of last year. Now, however, the higher military echelons are—as Vic puts it—growing restive over the whole subject, especially about costs and design negligence. The industry would do well to take note.

**C**ONFUSION as to what GSE is, is another prime fact. Many people in the business have conflicting ideas. Some throw in everything, including the kitchen sink.

For example, a self-serving publication prints in an article on missile GSE that the Air Force request for "new buy" GSE for 1960 is \$2.5 billion. It does not explain just what the money is for. But it defines GSE as the equipment, bases, installations, devices, and associated services needed to launch a missile, whether guided or unguided, test, military or research vehicle. Strangely, GSE for aircraft is left out of the grab bag.

The Air Force, however, officially defines GSE to include "ground operations (but not flight operations), handling, and servicing equipment." This means only equipment needed by maintenance and crewmen to ready missiles or aircraft for flight, and to get them into the air. It does not mean command control and warning equipment, such as BMEWS; other organizational and base support; development and test, or equipment mods, which account for a big chunk of the \$2.5 billion figure quoted. This figure, incidentally, includes aircraft GSE, not just missile, as discussed in the publication's article.

The right figure for AF FY 1960 GSE "new buy", as officially defined, comes to \$855.4 million. It includes both aircraft and missile GSE. Military requirements in this field are analyzed in Vic de Biasi's article, (page 49).

Throwing everything into GSE having the least connection with readying a vehicle and getting it into the air may serve to justify a publication's existence in the eyes of its publisher. But it hardly serves the designer and technical manager who need to know the GSE field.

*Randolph Hawthorne, Editor*

# LEAKS CAN BE STOPPED!



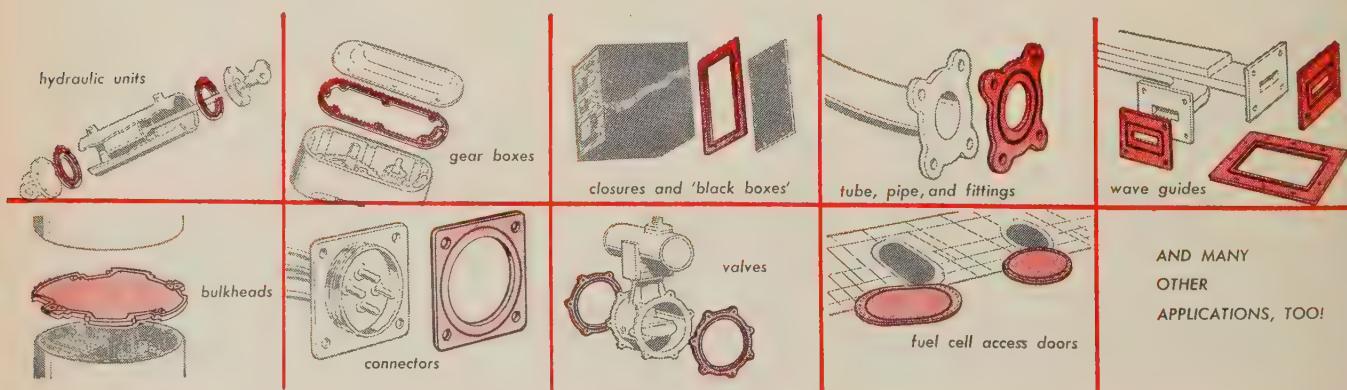
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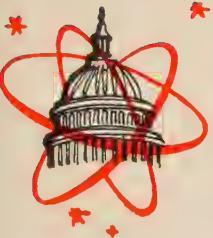
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SPACE/AERONAUTICS



# washington briefing

by A. N. Wecksler, Washington Bureau Chief

## More GSE cooperation between services

AN INTENSIVE 18-month study of policies and practices relating to ground support equipment is now in the process of completion, and the overall conclusion is that in missile development we have been racing far ahead of design of support equipment.

The study was initiated under the office of the now-abolished "Director of Guided Missiles," and has been continued under the office of the Director of Defense Research and Engineering. The principal work has been done by a committee representing GSE manufacturers.

**The study fully recognizes that in the rush to bring missiles to the operational stage, there has been a tendency to put a secondary emphasis on ground support equipment.**

Now the policy will be to redirect some of the effort and thinking on ground support—at least to bring the equipment support phases of weapon system current with the missile itself.

Some very basic questions were involved in the study of the status of ground support equipment. One was whether industry was capable of meeting the transportation and handling needs involved in guided missiles.

The Department of Defense was not interested in getting into the manufacture of ground

handling equipment, except as a necessity. The problem was the nature of the equipment—highly specialized and, in many cases, involving limited production runs.

**The conclusion reached is that industry is both anxious and able to provide the ground support equipment.**

Second basic question is the degree to which equipment can be standardized — also how much design improvement can be achieved.

The conclusions here are that it should not be the purpose of the Department of Defense to standardize everything, but that in developing different and new approaches, the new designs should be a known improvement over currently available equipment.

Finally, it was concluded from the study that ground support equipment should be designed in anticipation of the missiles that will be in production five years ahead. The thinking is that the planning and design of ground support equipment should be concurrent with the planning and design of the missile.

**This obviously is easier said than done, but the purpose is considered a valid one. An approach to this objective is a close relationship between the three using services. If the**

services went to the same source for ground support help on missiles which they were developing, the development of ground support would be keyed to the future planning on guided missiles.

As a result of the preliminary efforts of the ground support equipment study group, a procedure has been worked out under which if a problem of vehicle development is involved, the Detroit Arsenal experts would be called on as consultants. If the problem involved ground handling equipment, the Quartermaster Corps would be brought in as consultants. If the question involved generators, the Army Corps of Engineers would be the point of contact. If fire crash equipment is involved, the consultant group would be an Air Force unit, while if a dolly were involved, the experience of BuAer or BuShips might be called on.

It appears likely that out of this informal practice, a formal committee or board might be created to insure interchange of plans and experience. Also, it is hoped, that instead of each service having tailor-made equipment for each missile, the three services might find that by some modification in their specifications, one piece of equipment might be adequate to serve the needs of several missiles.

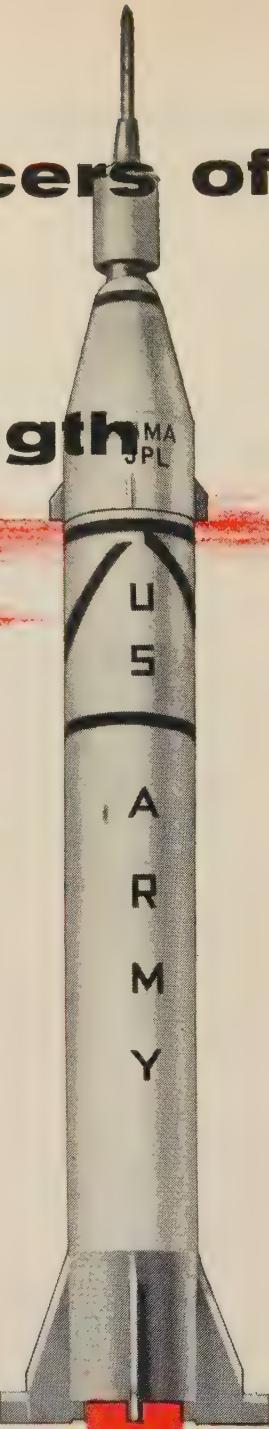
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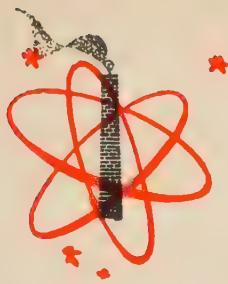


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## industry viewpoint

by Robert M. Loebelson, Associate Editor

### Primes ought to have GSE responsibility

THE BILLION dollar market for ground support equipment for aircraft and missiles has attracted many companies—not only the firms that have traditionally fulfilled defense needs as prime contractors but also subcontractors and companies that have had little to do with defense in the past.

So far as Donald W. Douglas, Jr., president of Douglas Aircraft, is concerned, there is no question as to which of these two types of companies should have the responsibility for supplying GSE. "I'm a firm believer in the weapon system concept," he declares. "The company that has the prime contract to develop an airplane or missile should also be responsible for the ground equipment that the vehicle needs to fulfill its mission."

That does not mean, Douglas declares, that the prime contractor will produce every piece of GSE needed for the airplane or "bird." "The primes obviously cannot be expected to be competent in every area. That's why they should and do call on other companies to provide various types of ground equipment as subcontractors. The biggest problem in the GSE area now is that every company, regardless of size, wants to become a prime contractor to the military services."

Douglas points out that the company responsible for the development and production of an airplane or missile cannot do its job without considering ground equipment and even the launching site. "You can't design a new vehicle in a vacuum," he states. "All segments of the entire weapon system must be taken into account by the prime contractor. And he is the one who must integrate all of the equipment so that the system works as it should."

The Douglas Aircraft president points to his own company's Thor IRBM as a case in point. "Sixty per cent of the engineering manhours that went into the Thor weapon system were devoted



DONALD W. DOUGLAS, JR., president, Douglas Aircraft Co.

to the ground support equipment. Douglas didn't build all of it. But we were instrumental in designing much of the GSE and selecting qualified subcontractors to produce it."

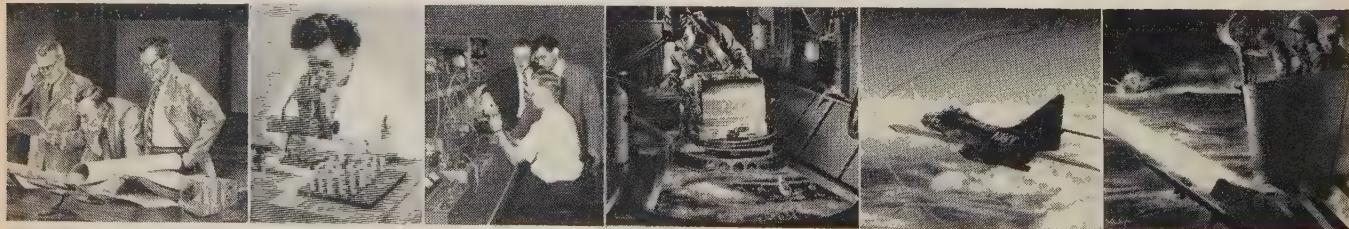
He concedes that most of the old-line prime manufacturers are worried about the loss of business to GSE builders, primarily because GSE often accounts for as much as 70 or 80 per cent of a ballistic missile weapon system. "But," he adds, "we are not trying to move into new areas. We don't expect to build equipment we are not qualified to produce. We do expect to be allowed to select qualified GSE producers—subject to the approval of the sponsoring military service—and to collect a fee for our management efforts on GSE for the weapons we produce as primes."

Douglas contends this is the most efficient way of evolving a complete weapon system. He also maintains the "fee on top of the subcontractor's fee" does not add to the total cost. "Even if we do collect a fee for integrating the GSE work of our subcontractors," he declares, "the money is included in our total earnings. We usually end up losing it either through direct taxes or by renegotiation."



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SPACE/AERONAUTICS



## technical management intelligence

THOUGH MANY PEOPLE in and out of the military services are maintaining that jet-powered manned aircraft are on the decline, the market for ground support equipment for large gas turbines is still substantial. Nicholas F. Frischhertz, manager of production support for GE's Production Engine Department at Evendale, Ohio, estimates this market at a minimum of \$50 million a year. He says GE's studies indicate the military alone will require that much GSE for large gas turbines. The needs of commercial jet users of course will raise the total substantially.

The GE official claims the military services will need more GSE for large jets than ever before because of the engines' increasing complexity and because of innovations being made by the large powerplant producers.

FRISCHHERTZ MAINTAINS the GSE requirements in the large engine field will not diminish even once hybrid powerplants are developed (turbo-ramjet and -rockets).

"And when we do come up with a workable nuclear-powered turbojet," he says, "even more GSE will be required."

Frischhertz points out that fuel handling equipment and test cells to check out new powerplants are becoming more complex and expensive than ever. "And," he adds, "the forthcoming use of higher energy exotic fuels will result in even more complicated GSE. When we have to deal with these hard-to-handle fuels, we will need much more remote control equipment and closed circuit television."

### We're shooting for quality in missile subs, says Navy Secretary

THERE'S SOME indication the Russians may have subs that can fire ballistic missiles, Navy Secretary William B. Franke stated at a Los Angeles press conference. We don't want to match them sub for sub, though, he went on. Rather we are trying for fewer subs but better quality.

THE NAVY'S nuclear capability is already being extended to upcoming frigates and cruisers, said Franke. If funds were available, he said, the Navy would like to go still further—to nuclear powered destroyers, for instance.

A nuclear carrier would be particularly valuable, since it could carry much more avgas—enough to triple the operational capabilities (in terms of fuel supply) of carrier planes.

SPACE/AERONAUTICS asked Secretary Franke to comment on industry complaints that the Navy is keeping a major portion of its R&D "in the house" at its own research centers—in contrast to the other greater participation of industry in the other services' R&D. He stated this problem is being studied intensively in top-level Navy policy discussions. No decision has been made one way or the other so far, he told SPACE/AERONAUTICS.

### Military worried about probable cuts in the budget for fiscal '61

HIGH-RANKING OFFICERS of all three military services are becoming deeply concerned about the fiscal '61 defense budget. Indications are that the services will lose funds for procurement, R&D, and operations and maintenance.

President Eisenhower's avowed intention to balance his last budget (to be submitted next January) obviously eliminates any possibility of increases in DOD spending. The exchange of visits by Khrushchev and Eisenhower also brings up the remote possibility of an easing of world tensions and a resulting drop in military requirements.

DEFENSE SECRETARY Neil H. McElroy is already on record with the statement that he intends to hold the military budget for '61 at the \$41 billion level of fiscal '60. Reductions therefore seem inevitable, because of rising costs due to the complexity of new weapon systems and to inflation.

Air Secretary James H. Douglas told the Air Force Association convention that USAF's planned buildup of a powerful deterrent bomber-missile force "will almost inevitably cause the postponement, even the elimination, of desirable projects." According to Douglas, USAF will give top priority to "our long range striking force, both ballistic missiles and manned aircraft, their instant readiness, and provision for warning against surprise attack."

McELROY TOLD the services to submit three types of budget estimates:

- the traditional "flash" estimate of mid-September, in which the services indicate what they really would like to have for worth-while projects if funds were not a consideration;

more on next page



## technical management intelligence

- an appraisal of what they could do with exactly the same sums they received in fiscal '60;
- a budget reflecting a 10 per cent cut in procurement, R&D, and construction money.

This 10 per cent represents the only flexibility in the entire budget structure. It is here that many marginal and not-so-marginal programs will be washed out.

THEORETICALLY, the budget presentations, traditionally made firm in mid-December but now due to be wrapped up by Thanksgiving, place about \$1 $\frac{3}{4}$  billion up for grabs. Included are about a half billion of Navy money, nearly a billion of USAF cash, and about \$250 million in Army funds.

The groundwork for some cutbacks is already being laid. Examples include the Navy's cancellation of the Martin P6M SeaMaster flying boat, the Navy-USAF decision to eliminate the boron fuel program, the axing of Mach 3 GE's J93-5 "chemical" engine, and cutbacks in the B-58.

### **USAF's cutbacks will fall on manned aircraft**

HIGH USAF OFFICERS, including Maj. Gen. William T. Thurman, assistant for production program in the office of the DCS-Matériel, have indicated to SPACE/AERONAUTICS that production cuts will probably be made in the manned aircraft program. The present ballistic missile program—Atlas, Titan, Minuteman, Polaris, Pershing—are "solid", it is claimed.

These comments and the elimination of the J93-5 point to a major cutback on the NAA B-70 Valkyrie bomber (which will be very costly even in production quantities). Since USAF will get the F-108 interceptor from NAA at least a year sooner than the B-70, it will be able to get Mach 3 experience without firm commitments in fiscal '61 on B-70 production.

There is little doubt, however, that the B-70 will be continued in '61 as an R&D vehicle.

SOME FUNDS for '61 will be obtained by not re-ordering the Douglas Thor and Chrysler Jupiter IRBMs. Production commitments made with funds from '60 and earlier years are believed sufficient to meet USAF and NATO's needs—unless more NATO countries agree to accept IRBMs, which seems unlikely.

NASA also will feel the pinch in fiscal '61. It had planned to move from the half-billion voted for

space research in fiscal '60 to a billion or more for '61. The Administration's economy drive rules out such an increase—unless the Russians give the program a boost by stealing another march on us and putting a man into space within the next six months, for instance.

### **Closer supervision, stricter accounting in store for USAF contractors**

EVERY FIRM in the aerospace industry will be immediately affected by the forthcoming DOD decisions on the budget. At the AFA meeting, Lt. Gen. Mark E. Bradley, Jr., DCS-Matériel, and Donald R. Jackson, deputy to the Assistant AF Secretary for Matériel, outlined some of the steps the Air Force is planning to take:

- require current and completely accurate information—including "certificates of accuracy"—from prime contractors before signing incentive-type contracts;
- extend this policy of certificates of accuracy to first-tier subcontractors when sums of over \$100,000 are involved or there is no effective competition;
- demand early "definitization" of letter contracts—in the past, Bradley said, company negotiators caused delays by their reluctance to disclose information to USAF auditors and price analysts;
- insist that contractors cut down on their overhead, especially on the policy of holding on to engineering and other talent in hopes of getting future business—Bradley said the industry must realize that the era of long production runs is over for good;
- reserve the right to approve or veto any proposal involving team bids for new weapon systems—in some instances, according to Jackson, USAF will even substitute one company's components for another's, even though the first company is not a member of the winning team;
- do considerably more "looking over the shoulder" of prime weapon system contractors—Bradley indicated USAF will veto subcontractors if it considers them unqualified;
- restrict further government-financing of industrial facilities, primarily by insisting that, before getting the contract, a potential prime contractor outline which systems he will "make or buy";
- minimize the competitive advantage of con-

**more on page 26**



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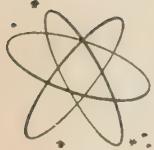


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## technical management intelligence

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JACKSON PREDICTED the upcoming changes in fiscal '61 and later years will force the aerospace industry to undergo major adjustments. The procurement sums spent by USAF will not go down, he explained, but the absence of long production runs will cause the industry's manpower figures to drop.

How many firms will survive the changes will depend on how well each company meets the competitive challenge. In any event, Jackson added, there will be a continuing shift of business to electronics firms—and perhaps away from the traditional aircraft companies. Jackson doubted, however, that the services will be able to provide enough business to match the electronic industry's capacity to produce military equipment.

### VTOFs and cargo planes among USAF's "essentials"

USAF'S CHIEF OF STAFF, Gen. Thomas D. White, has outlined to the AFA convention, USAF's 10 essentials for national survival—not items that would be nice to have, but the 10 items needed most urgently "to achieve pre-eminence in aerospace":

- intercontinental ballistic missiles;
- air-to-surface missiles launchable from bombers;
- follow-on long range aircraft, perhaps including a plane that could bomb, intercept, and carry cargo (in various configurations);
- advanced tactical systems, including missiles and VTOL aircraft;
- a ballistic missile warning system starting with BMEWS and extending beyond the ARPA-AF Midas infrared satellite system;
- long-range defenses using F-108-type interceptors, Bomarc-type missiles, and advanced techniques now being studied by ARPA;
- a network of instantaneous, reliable, and secure communications, including the Notus satellites now under development;
- advanced recon systems, including the AF-ARPA Samos (formerly Sentry);
- a modernized cargo fleet of turbofan and turboprop aircraft;
- advanced manned space systems extending beyond the X-15 and Dyna-Soar programs.

NEXT YEAR'S BUDGET will be about the same as this year's, Dr. Herbert York, DOD's Director of Research & Engineering, told the Western Electronic Show & Convention (Wescon) in San Francisco, Calif. Contrary to popular opinion, which overestimates Congress' role, he stated, the budget is mainly influenced by the decisions of the Bureau of Budget. It is based essentially on extrapolations from the previous year's figures, the Treasury's estimates of Government income, and the temper of the population at large (as the Government sees it), York said.

### Dr. York calls for "sophistication that reduces complexity" as design goal

DISCUSSING THE FUNDING of new R&D ideas, York pointed out that of course it isn't true that the richest country in the world can't afford \$100,000,000 for one or two new schemes. The trouble is that hundreds of such projects are proposed. Problem becomes one of winnowing the very good ideas from those that are just good.

Designers, said York, must pay more attention to the kind of "sophistication that reduces complexity." Much complex equipment that is built can't be used "because our troops can't work [it]."

One of the reasons why our projects take longer than the Russians', York explained, is that at some point in a program someone invariably decides to change a tube, a booster, or what not, and holds up the project. The Reds finish projects without interruptions for "improvements", York stated.

YORK ALSO called for more interest in "unglamorous" fields like short range missiles, Army and Navy modernization, etc. Space programs, he pointed out, get only five per cent of the budget but "50 per cent of the interest." It's hard to get good people to work in the unglamorous fields, York stressed.

INFLATION caused USAF to reduce its fiscal '60 order for 40 Convair B-58 bombers to 32. Despite the change, output of the Mach 2 bomber at Convair—Ft. Worth is programmed through December '61. The cutback also will affect GE-Evendale's output of the J79-5 engine, which powers the B-58.

# **Explorer VI**

**is a**

**space laboratory**

**orbiting**

**around**

**the**

**earth**

**with**

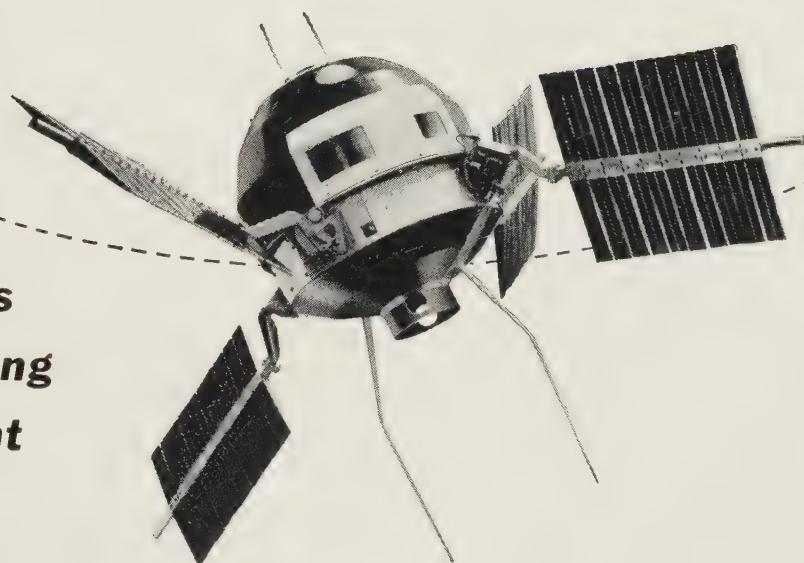
**paddles**

**capturing**

**sunlight**

**for**

**power**



The scientific data that will some day enable us to probe successfully to the very fringes of the universe is being recorded and transmitted at this moment by the space laboratory

Explorer VI, a satellite now in orbit around the earth • This project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, will advance man's knowledge of: *The earth and the solar system . . . The magnetic field strengths in space . . . The cosmic ray intensities away from earth . . . and, The micrometeorite density encountered in inter-planetary travel* • Explorer VI is the most sensitive and unique achievement ever launched into space. The 29" payload, STL designed and instrumented by STL in cooperation with the universities, will remain "vocal" for its anticipated one year life.



How? Because Explorer VI's 132 pounds of electronic components are powered by storage batteries kept charged by the impingement of solar radiation on 8,000 cells in the four sails or paddles equivalent to 12.2 square feet

in area • Many more of the scientific and technological miracles of Explorer VI will be reported to the world as it continues its epic flight. The STL technical staff brings to this space research the same talents which have provided systems engineering and over-all direction since 1954 to the Air Force Missile Programs including Atlas, Thor, Titan, Minuteman, and the Pioneer I space probe.

**Important staff positions in connection with these activities are now available for scientists and engineers with outstanding capabilities in propulsion, electronics, thermodynamics, aerodynamics, structures, astrophysics, computer technology, and other related fields and disciplines.**

**Space Technology**

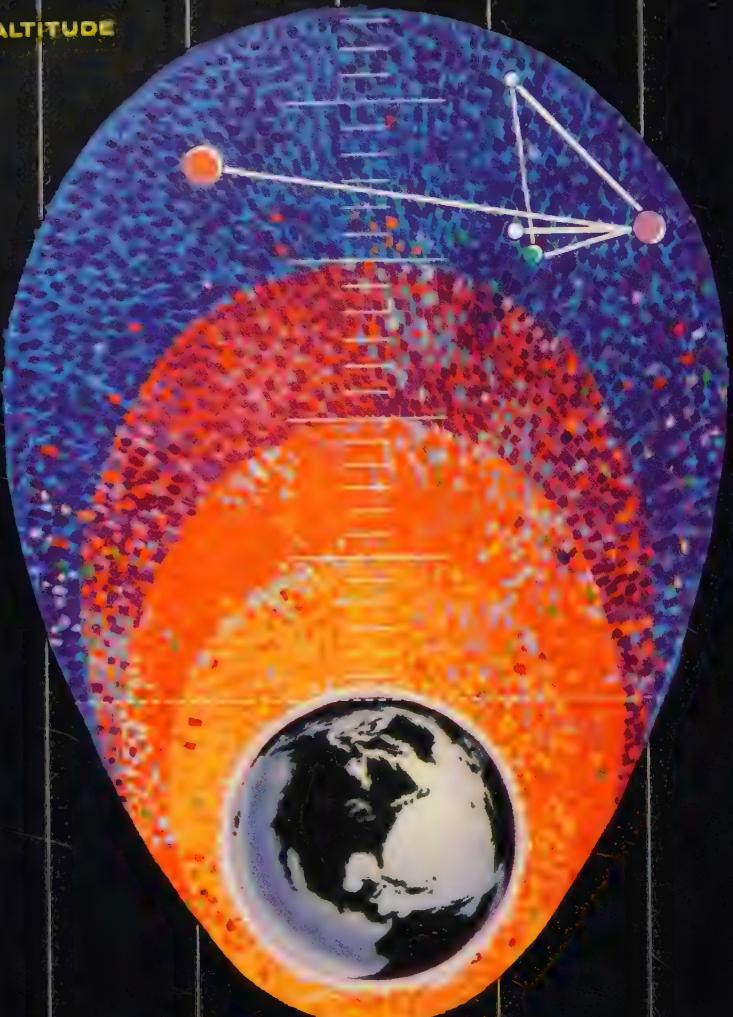


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to find, and not to yield"  
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## space/aero engineering intelligence

SOVIETS FIGURED the impact of their moon rocket on September 14 to within 84 seconds of the time of arrival. The entire trip took about 35 hours. According to the Russians, their instrument package landed some 250 miles off center after traveling 236,875 miles. Midcourse or terminal guidance was used to achieve this accuracy.

On the basis of the accuracy of the predicted time of arrival and point of impact, it is estimated that a Russian ICBM with the same degree of trajectory control could hit within 5½ miles of its target.

### **Red moon vehicle's instrument package 859.8 lb, had controlled environment**

LAST STAGE of the multi-stage Russian vehicle was officially reported to weigh 3342 lb (excluding fuel). The instrumentation package, which was separated from the guided last stage, weighed 859.8 lb.

Instruments inside the pressurized and temperature-controlled package are believed to have recorded data on the magnetic fields around the earth and the intensity and composition of the radiation belts around the two bodies, the density of matter in space, and meteoric particle impacts. All the data were radioed back. The signals stopped at the time of impact.

### **"Scooping" vehicle proposed for refueling in space**

"FILLING STATION" in space was suggested in a paper at the Fourth Symposium on Ballistic Missile Space Technology (co-sponsored by USAF-BMD and Space Technology Labs by Felix Berner and Morton Camac of Avco's Everett (Mass.) Research Lab.) It would be a satellite that scoops up air in the upper atmosphere, stores oxygen and nitrogen in liquid form, and supplies LOX to spacecraft for use as a propellant, in environmental control, and the like. The nitrogen would be used as propellant resupply for MHD spacecraft and for solar and nuclear reactor heating systems.

The Avco engineers reported their studies showed air-scooping is feasible from slightly below 300,000 ft and to higher altitudes with an elliptical orbit and at over 320,000 ft with a circular orbit. A nuclear vehicle could operate over both ranges.

←Write in No. 17 on Reader Service Card

Berner and Camac also suggested a scooping vehicle using solar batteries. This design would be rectangular in cross-section and operate at altitudes above 550,000 ft in free-molecule flow, in which conventional compression isn't practical.

### **"Scooped" fuel could save a lot of money**

ECONOMIC COMPARISON of the scooping vehicle with conventionally launched, fully fueled and supplied vehicle shows the scooping vehicle would start being cheaper once it had collected an amount of air equal to twice its own basic weight—and it would be cheaper by quite a lot, Berner and Camac asserted.

MANNED SPACECRAFT can be designed now, STL's J. S. Brady told the symposium. "We . . . possess sufficient data and technology to achieve a workable, if preliminary, design based upon a selection [among] and extension of existing techniques," he stated. One reason why some people believe a manned space vehicle is still impracticable, Brady indicated, lies in their failure to see man as a functioning system component.

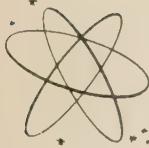
Brady based himself on a division of operational functions into intra-, supra-, and extra-system classes. Intra-system functions are implied by such terms as detection, transduction, actuation, tracking, etc.; supra-system functions by selection, decision, etc.; and extra-system functions by repair, fueling, etc.

"It should be apparent," said Brady, "that the objections to man as a system component refer almost wholly to intra-system functions and that machine capabilities in supra- and extra-system functions are extremely limited and achieved only at great cost in time, space, weight and reliability."

### **Spacecraft designer must keep man's functions and capabilities in mind**

TO MAKE THE BEST USE of man as a vehicle component, Brady stated, redundancy should be used only where required. In addition, man-operated information and control systems should be tailored to the functions and capabilities of the human operator.

As an example, Brady noted that a display that  
more on next page



## space/aero engineering intelligence

gives only the desired end point, or goal, the system's deviations from it (or error), and the control action needed to achieve the end point (command indication) restricts man to the role of a "servo-follower". A situational display should be used instead, Brady said. This display would not only show the end-point data, but also place end-point and the system within some frame of reference, or the "action environment".

### **Impact tolerance described by single parameter in GE studies**

IMPACT TOLERANCE studies on mammals such as mice may provide a simple design criterion for impact landings of manned satellites and space vehicles, M. Kornhauser and R. W. Lawton of GE's Missile & Space Vehicle Dept. told the symposium. Such studies show mice have an impact tolerance that can be described by the single parameter  $\Delta V$  in the short-duration region—any velocity change over 30 fps is dangerous to mice, regardless of the peak acceleration or the shape of pulse.

The impact tests were run with drop tester capable of velocity changes up to 90 fps. Various stopping devices were used to shape the acceleration-time pulses. The practical impact parameter range for the "mouse sensitivity curve", the GE engineers stated, were covered by varying the impact duration from less than 0.5 millisec to about two millisec and the peak accelerations from 500 to 10,000 g.

SD-2 SURVEILLANCE drone will be developed for the Army by Aerojet-General. The improved version, whose first flight test is set for early '60, will have some of the Army's latest sensory devices, Aerojet states. Advanced flight testing of the photo surveillance equipment, including designs for night missions, is underway at Yuma, Ariz., in the original version of the SD-2.

The drone has an operating weight of 930 lb, including 90 lb fuel and 100 lb payload. It can be recovered by parachute. Powered by a Lycoming piston engine rated at 185 bhp at sea level, it has a top speed of about 300 knots. Length is 167 in., span 128 in.

OCEANOGRAPHY loomed large in a number of important official statements in recent weeks. Dr. Parker of the Office of the Secretary of Defense told a press conference at the Anti-Submarine Warfare Symposium in San Diego, Calif.,

that work in this area had top DOD priority. Dr. York in his Wescon talk also singled out oceanography as a key area in which our basic knowledge is in very poor shape.

### **Soviets probably ahead of us in studies of the ocean under the ice pack**

DR. J. W. HORTON, civilian technical director of the Navy's Underwater Sound Lab in New London, Conn., told the ASW meeting this country desperately needs more data on the ocean under the polar ice pack. This ocean has unusual features, he noted, such as its extreme quietness and scarcity of marine life.

Russia, Horton reported, has some 500 people studying the arctic regions—as against only a handful from the U. S. The Russians also have 17 oceanographic vessels—several times more than we, said Horton.

Industry interest in the underwater fields was shown by the turnout of 950 at the ASW conference. The Navy had expected only 300-400.

AERODYNAMIC CHANGES helped Douglas DC-8 meet FAA's new jet requirements and gain its type certificate a month ahead of its target date. The present certificate covers the basic Douglas Jetliner powered by P&WA JT3s.

One design change calls for two leading-edge slots—80 and 32 in. long, respectively—on the inboard section of each wing to provide better takeoff and landing capabilities. The wing tips have been extended 16 in. each and changed in shape.

### **Sodium vapor cloud ejected from rocket rose from 50 to 150 miles**

EXPERIMENTAL CLOUD of sodium vapor was ejected from a Nike-Asp sounding rocket in NASA wind activity tests. Rising from an altitude of 50 miles over the eastern seaboard, it reached peak of 150 miles and was seen as far south as Vero Beach, Fla., and as far north as Dayton, Ohio. Five tracking stations, NASA reports, got good data, on wind velocities and directions as well as on diffusion at altitudes at which it had never been studied before.

Nike-Asp was 27 ft long and had a takeoff

*more on page 32*



59-33



## Around the world in 80 minutes

Phileas Fogg needed eighty days to see what the Explorer scans in minutes. Ex-Cell-O Corporation was not then in business to help speed his trip—it was 1923 that Ex-Cell-O started making aircraft parts to tolerances until then deemed impossible in production.

Forty years of Ex-Cell-O experience in high-precision design and manufacturing have helped hurl the Explorer into the sky—have helped guarantee that Ex-Cell-O rocket and missile components embody the delicate strength essential in space.

Twenty-four Ex-Cell-O facilities in the United States specialize in accuracy by the ounce or by the ton... for the future.

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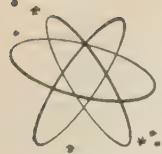


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MAN AND MISSILES FLY HIGHER, FASTER, AND SAFER WITH PARTS AND ASSEMBLIES BY EX-CELL-O AND ITS SUBDIVISIONS:  
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weight of 1550 lb. The 75-lb payload included 10 lb of sodium pellets mixed with thermite compound, which was burned to provide cloud.

POLARIS is slated to be operational by late '60, Navy Secretary William B. Franke told a Los Angeles press conference. The biggest problem now, he stated, is to find a way of communicating with the submerged sub under all conditions. At present, the sub couldn't be reached at certain depths. All possible design approaches are being explored, said Franke, including the use of communication satellites.

## **Ground power supply using fuel cells will weigh only 22 lb total**

BRIEFCASE-SIZE electric ground power supply is being developed by GE's Aircraft Accessory Turbine Dept. for BuShips. The power pack uses ion exchange membrane-type fuel cells to convert chemical energy directly to electricity.

The entire package weighs 22 lb, including 4.5 lb for a replaceable metallic hydride cannister that lasts 14 hours. Output is 170 W. First hardware is to be delivered next spring.

FUEL CELL EFFICIENCIES have often been quoted at up around 70 per cent. But, says GE, they would very seldom be designed to this value. The duty cycle must be analyzed and the end product optimized for either weight, volume, or cost. An extremely efficient fuel cell would have a low fuel consumption, GE engineers point out, but its size and weight would be prohibitive.

## **Broad re-entry study to be tackled by Brooklyn Poly**

RE-ENTRY STUDY CONTRACT was awarded to Brooklyn Poly by ABMA. The re-entry characteristics of various types of space vehicles are to be investigated. Poly says both manned and unmanned craft will be covered.

Poly's "Project Orbit" will include theoretical studies of feasible shapes for space ships and satellites. It will also cover orbits satellites might possibly follow, problems of heating during re-entry, and the problems of deceleration in the final dive through the dense lower atmosphere.

MINUTEMAN NOSE CONE award to Avco calls for a program of basic research through

prototype development, including ablation studies and the development of ablative materials. The contract also covers the development of advanced materials for rocket nozzles—presumably needed for controlled re-entry.

T55-L-3 COPTER ENGINE passed its 50-hour preliminary flight rating test. As a result, the Lycoming engine has been officially uprated from 1850 to 1900 shp. Lycoming was able to show an SFC of 0.617 (as against a guarantee of 0.677).

## **One-ounce motor generator equals performance of 2½-oz unit**

SIZE 5 MOTOR GENERATOR developed by Daystrom Transicoil is said to be the smallest yet. Weighing one ounce (including leads), it is claimed to do the same job as a size 8 unit weighing 2½ oz. Performance specs are: minimum stall torque, 0.11 oz-in.; no-load speed, 10,000 rpm; maximum null voltage, 12 mv.

PLASMA ENGINE work at Republic Aviation is being expanded. The company reports it is more than doubling the size of its lab and beginning the construction of a second experimental magnetic pinch plasma engine. So far, Republic says, it has generated an estimated thrust of 8000 lb for one microsecond with the first experimental engine. The new engine will enable the lab to study the feasibility of cycling such thrusts for continuous operations.

## **Cold-molding in 24-in.-diameter crucible foreseen**

COLD-MOLD CRUCIBLE development contract awarded by AMC to Mallory-Sharon Metals calls for construction and test of a 14-in.-diameter induction furnace with a water-cooled crucible. Reactive metals like titanium are to be melted in the furnace. Cooling the crucible will keep it from reacting with and contaminating the metal.

Mallory-Sharon expects the process to be usable eventually with crucibles up to 24 in. in diameter and with metals such as zirconium, hafnium, columbium, and tantalum.

TRIPLE-THREAT thermoelectric system Westinghouse is developing for BuShips will serve as air conditioner, heater, and refrigerator-freezer. The experimental system will be built of modules that can be individually replaced to

*more on page 34*



# dramatic NEW Weapon

**FOR ANY STRIKE MISSION · IN ANY WEATHER · FROM ANY BASE**

THE NAVY'S A3J VIGILANTE is several different kinds of airplanes in one. It depends who you are—what your mission is—when you climb into the sky.

You could be a "deck level" attacker out to execute a low-level mission in a "brush fire" war. You could be a stratosphere bombardier assigned to retaliation in a full-scale nuclear conflict. Irrespective of radar contact, your aircraft would be electronically equipped to attack a target obscured by "ceiling zero" weather. Or with the A3J's highly accurate navigational system you could be pin-pointing defenses for intelligence.

But this for certain: you would have the ability to operate from either a carrier deck or a tactical base ashore. You would be able to strike effectively from any altitude—any attitude—and in any visibility day or night. You would have the versatility to choose your weapons before take-off—the flexibility to choose the best possible attack method at the last possible moment.

This would be your machine: far-reaching, two-place, Mach 2, twin GE jets, fully integrated bomb-nav system. They call it Vigilante, now in flight evaluation by the Navy. Conceived and developed by ...

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Columbus, Ohio





change system size and capacity. Switches from heating to cooling and back will be made by simply reversing the flow of electric current through the thermoelectric components.

KRYPTON 85 nuclear battery developed by Universal Winding's Patterson Moos Division is available in limited quantities for test and evaluation. Advantage of krypton is that it is an inert gas that is not absorbed by the body. Therefore it's much safer and easier to handle than other radioisotopes, says Patterson Moos.

The battery originally was developed for timing circuits and pulse energy sources. It may also find use in memory and programing devices, since it can be built to a current rating of 200-1000 Uamps, an open-circuit potential of several thousand volts, and a linear charging rate from several hundred to 1000 V.

FUEL ENERGY MANAGEMENT study being made by U. of Minnesota for the Air Force covers all conditions from takeoff to landing. Findings will apply to atmospheric interceptors and bombers, orbital gliders and interceptors, and trans-orbital, lunar, and planetary vehicles. Purpose of study is to make best use of propellant energy through measurement and control of critical characteristics.

## **Shape of ionization in outer space to be cleared up by satellite data**

PADDLEWHEEL SATELLITE data is expected to help prove or disprove a new concept of the distribution of ionized matter in outer space. Prof. Robert A. Helliwell, of Stanford University's Electronics Lab, has advanced the theory that ionization irregularities high above the ionosphere—at up to several earth radii—take the form of shell- or banana-shaped ducts. If this is true, the ionization concentrations might be exploited for radio communication.

These ducts postulated by Helliwell are aligned with the earth's magnetic field. Concentrated ionization is believed to be only 10-20 per cent stronger than the surrounding ionization. Although low, it should be enough to form a kind of channel for conducting radio signals with great efficiency.

SHAPED EXPLOSIVE CHARGE is the secret of Chance Vought's new pilot escape capsule

development program. The explosive is placed in three-sided strips of metal of varying lengths. A V-shaped strip of copper then is pressed into it under high pressure to seal the open side and form the lined shaped charge. The strips are then formed to follow the contours of structural members inside the aircraft fuselage. In areas using lighter metals, as on aircraft skin, the explosive is placed inside a copper tube and the shaped charge is impressed along the tube's length.

With strips and tubes circling the inside of the aircraft and mounted on the parts to be severed, the cockpit capsule can be separated from the rest of the aircraft in microseconds. The blast forces are confined closely to the structural material that is being cut. The weight increase is said to be negligible. Once separated, the sealed capsule makes a parachute descent.

## **Lube's temperature and radiation properties studied**

HIGHLY STABLE synthetic lube being evaluated for use in hypersonic aircraft is one of a group of polyphenyl ether compounds developed by Monsanto Chemical for ARDC. Six thousand pounds of it are being produced for evalution.

The new fluid lubricant is described as highly stable under nuclear radiation and high heat. Monsanto reports the fluid will remain stable and retain its lubricating ability at temperatures as high as 900 deg F.

PRECIOUS-METAL filters consisting of tiny, identical spheres welded together into pads have been perfected by Engelhard Industries' Baker Platinum Div. for missile use. The platinum and palladium filters can withstand temperatures of over 3000 deg F and be used with highly corrosive fluids.

Pore sizes from five up to 40 microns can be produced with an accuracy of 10 per cent, says Baker. Filter porosity varies from 25 to 35 per cent, depending on the size of the spheres.

INTEGRATED CONTROL system being developed by General Dynamics for nuclear subs will probably be patterned after bomber flight control systems. Goal is to shrink the size of submarine crews from the 100 men now needed to a "flight" crew of 12 or 15 men. The system will include automatic control of depth (or altitude), cruise speed, reactor, ballast trim, etc.



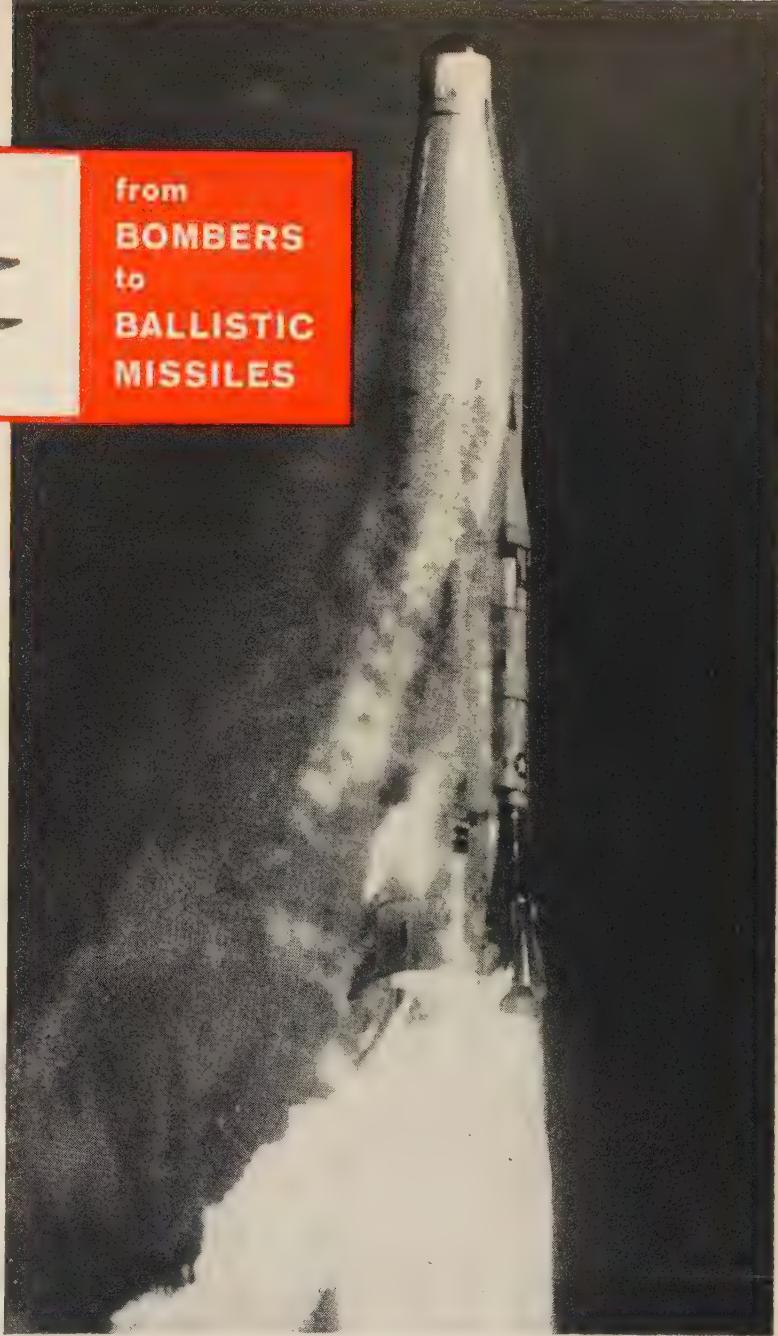
from  
**BOMBERS**  
to  
**BALLISTIC**  
**MISSILES**

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About the only point of similarity between the *Curtiss-Condor* bomber and the *Atlas* is the job both were designed to do. The intercontinental *Atlas* typifies the design progress of the aircraft industry in a short span of years.

The ever increasing speeds demanded for new missiles and aircraft have called for constant changes in fasteners—making them smaller, lighter and stronger—all at the same time. The result of ESNA's 28 years of serving the changing needs of the aircraft industry is the largest and most varied line of self-locking fasteners available from any source. ESNA is ready to continue to match fastener progress to aircraft and missile progress—making new Elastic Stop nuts to meet new requirements.

Complete design details of ESNA's line of aircraft fasteners are yours for the asking. Write to Department S27-1050.

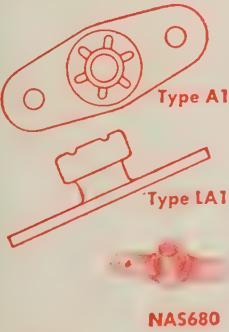


The *Atlas* is built by the Convair Division of General Dynamics Corporation.



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As increasing emphasis was placed on weight savings ESNA "shaved" dimensions and created the first lightweight two lug design (LA1) in 1944 . . . which has now evolved into today's standard NAS680. The continuing special requirements of the aircraft industry have resulted in many modifications of that first two lug design . . . such as those illustrated below . . . all available from ESNA.



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Deep Ctsk.



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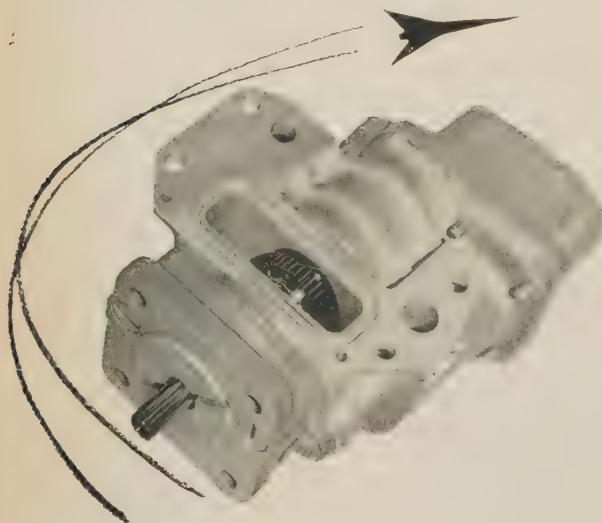
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Model 100-846 is a typical, highly reliable fuel component . . . representative of a series of units designed and developed by Great Lakes to satisfy special requirements. This model designed to meet MIL E 5009 A, is for turbine power plants. Provision for flow control drive and mounting is incorporated within the pump configuration.

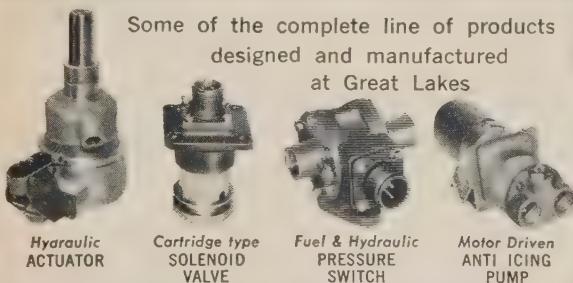
Great Lakes can save you time and money by incorporating existing units in your design plans at an early stage. You will find that our Engineering, Designing, Testing, and Production Ability will augment your own facilities.



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## calendar

October 5-7—Seventh Anglo-American Aeronautics Conf., Institute of the Aeronautical Sciences, Hotel Astor, N. Y.

October 5-7—Fifth National Communications Symposium, Institute of Radio Engineers' Professional Group on Communications Systems, Hotel Utica, Utica, N. Y.

October 5-9—National Aeronautic Meeting, Society of Automotive Engineers, Ambassador Hotel, Los Angeles, Calif.

October 6-8—Radio Interference Reduction & Electronic Compatibility, Conf., Museum of Science & Industry, Armour Research Foundation, IRE's Professional Group on Radio Frequency Interference, classified session on Oct. 8, Chicago, Ill.

October 6-8—Industry-Military Quality Control Management Symposium, Oklahoma City Air Materiel Area, Tinker AFB, Oklahoma City, Okla.

October 6-9—International Symposium on High-Temperature Technology, Stanford Research Institute, Asilomar Conference Grounds, Monterey Peninsula, Calif.

October 7-8—Second Advanced Propulsion Systems Symposium, Air Force Office of Scientific Research, Avco-Evrett Research Lab., New England Mutual Hall, Boston, Mass.

October 7-9—Sixth National Symposium on Vacuum Technology, American Vacuum Society, Sheraton Hotel, Philadelphia, Pa.

October 7-9—Solid Fuels Conf., American Society of Mechanical Engineers, American Institute of Mining & Metallurgical Engineers, Cincinnati, Ohio.

October 8-10—Society of Experimental Test Pilots' Symposium on Pilot's Role in Space Exploration, Beverly Hilton Hotel, Beverly Hills, Calif.

October 12-14—15th National Electronics Conf., Hotel Sherman, Chicago, Ill.

October 12-16—National Aeronautics & Space Administration's 1959 Inspection, Langley Research Center, Hampton, Va.

October 12-16—Exploring Research Management, American Management Assoc., Hotel Astor, N. Y.

October 14-23—"William Tell II" Seventh World-Wide Interceptor Weapons Meet, Air Defense Command, Tyndall AFB, Panama City, Fla.

more on page 45  
Write in No. 21 on Reader Service Card →  
SPACE/AERONAUTICS

## Research is the beginning . . .

These research rockets probe the upper regions of the atmosphere. The total flight of each vehicle is measured in mere minutes — yet the payoff is a rich harvest of facts about the little-known "inner space" we must cross before we venture farther into the unknown.

At Westinghouse, research is the beginning. Research is the bright spark that sheds light on a world. In this world of Westinghouse, *research is first* — in terms of time, of facilities, of funds allocated. Over 185 million dollars are being spent this year by Westinghouse for research and development alone. Perhaps most important of all, research is first at Westinghouse as a long-term company policy.

The Westinghouse Advanced Systems Planning group (WASP) is evidence of this philosophy. Here, select scientists and engineers do almost nothing but think — planning for defense requirements due perhaps five years or a full decade from now. In 33 different defense system areas, WASP is a single point of contact between defense planners and one of America's largest and most versatile firms — with 29 different facilities capable of study, design, or manufacturing assignments.

Some of the most promising products of research from the world of Westinghouse are: *Thermoelectricity* — the direct conversion of heat into electricity. Important spacecraft applications are already apparent. Through *molecular electronics*, drastic reduction in weight, size, power, and heat dissipation requirements will permit space vehicles and satellites to perform a greater number and wider range of tasks.

*Like the sounding rockets on this page, research at Westinghouse opens the door to new worlds.*

**YOU CAN BE SURE . . . IF IT'S**

# Westinghouse

*Illustrated, a Nike booster hoists an Asp rocket to an altitude of 37 miles, to study nuclear detonation effects. A Farside rocket (4000 mile ceiling) rises directly through the balloon which has carried it to the stratosphere. Arcon, an advanced general purpose vehicle lifts a 40 lb. payload 250 miles; and Aerobee — the basic high altitude exploration vehicle — rises to 193 miles in its latest Aerobee-Hi version. Argo is the rocket for the nuclear explosive investigation of the radiation belt that surrounds the earth.*



## Stepping stones to space . . .

In the history of the conquest of space, these vehicles will be counted among the true pioneers; they are the first American vehicles to orbit the earth.

Like the small satellites, which are test vehicles for large spacecraft, Westinghouse test equipment precedes and insures the flights of the future. Westinghouse is the single-source supplier of research and test equipment for the aero space industry.

Over half the wind tunnel horsepower in the U.S. was provided by Westinghouse. Today, radiant and rf heating, plasma jet, blowdown and shock tunnel facilities all over the country depend on Westinghouse power supplies and control systems. Westinghouse induction coils helped achieve 32,400 mph in Hot-shot II tests.

Test stands for evaluation of any type of rotating equipment are other well-known products from the world of Westinghouse; a-c and d-c motor powered test stands for rotor blades, constant speed drives, generators, fuel pumps, and many other aircraft, missiles, and spacecraft components. For faster, more accurate research and production testing of these components, Westinghouse has designed a 400-cycle power generator and distribution system around the only 400-cycle high-frequency bus duct in existence. In yet another area, Westinghouse created the world's largest amplifier to vibration-test Polaris components.

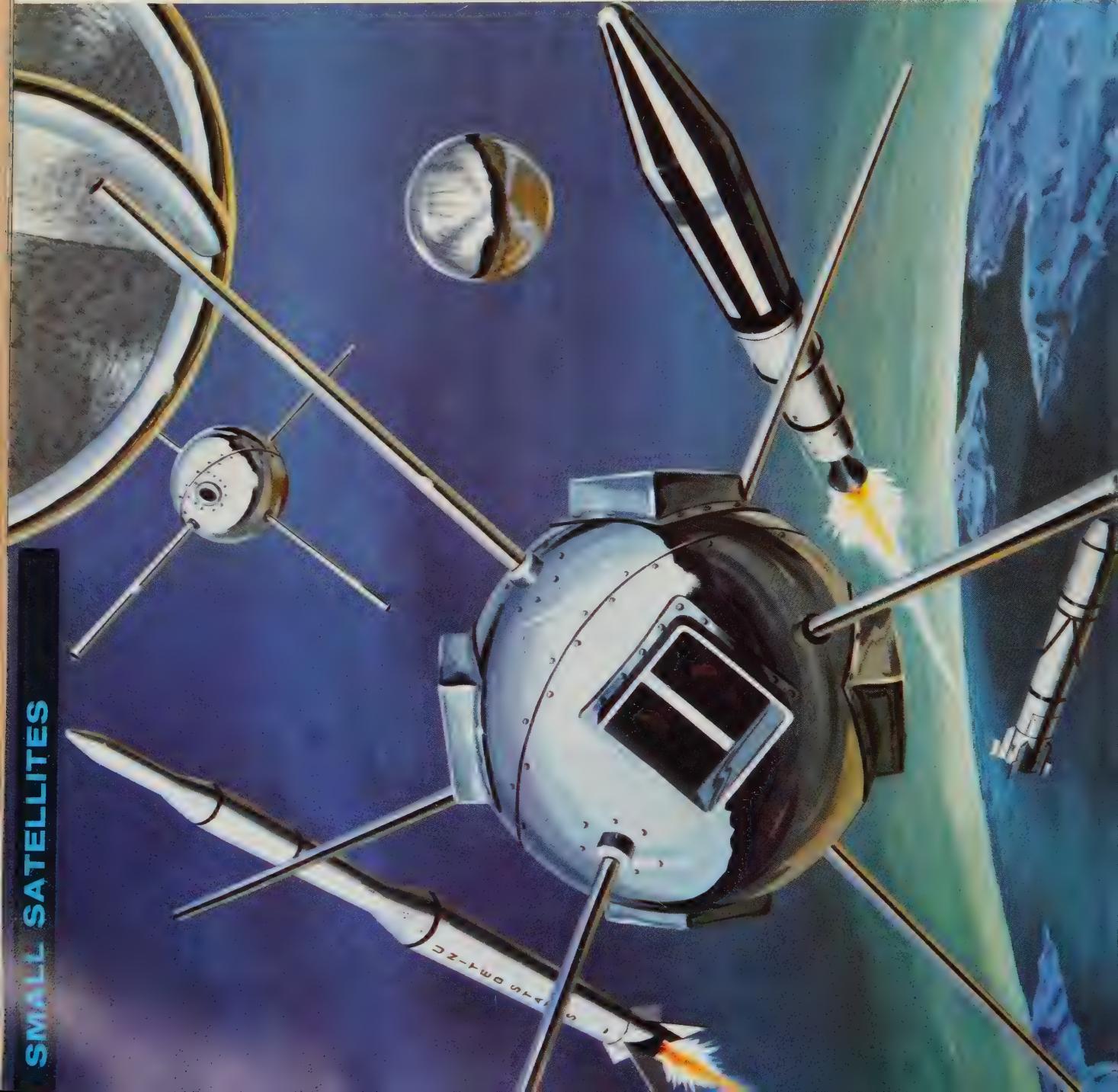
Trade on this unmatched capability in standard or custom-designed test equipment . . . and minimize the problem of selecting and relating equipment from multiple sources.

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# Westinghouse

*Illustrated, the original American satellite, Explorer I, as it heads into its orbit. Vanguard I, the second successful satellite of the U.S., shows off its solar batteries which feed 'eternal' power to its electronic payload. Also shown: the full scale Vanguard satellite and the solid-fueled Scout satellite launcher due to fly soon. Scout will be the first economical vehicle to orbit a 150-lb. payload. Lastly, two inflated foil satellites: the globe is the forerunner of tomorrow's communications satellite, the other shape is a 'corner reflector' for radar tracking.*

**Clockwise:** Vanguard I, (7 o'clock) • Scout, (9 o'clock) • Scout, (1 o'clock) • Van-guard 22-lb. satellite, (12 o'clock) • corner reflector, (1 o'clock) • Van- • small-scale communications satellite, (3 o'clock) • Jupiter C Booster, (5 and 6 o'clock) • Explorer I



Here are the first payloads-in-orbit big enough to shape our earth-bound lives. Communications, weather, reconnaissance and astronomy satellites, each one paves the way for the time when human teams will supplement the robots now circling the earth.

Westinghouse, too, is helping to bring about the era of big spacecraft. Metals and materials shaped to space age needs are a major Westinghouse capability. The world of Westinghouse has already brought historic contributions to American metals technology: in steam turbine metallurgy, magnetic metal alloys, high temperature alloys.

Beyond basic research, Westinghouse materials engineering teams bridge the gap between ideas and applications — develop, evaluate and apply new metals and processes. Now, the new Metals Plant at Blairstown, Pennsylvania, calls on advanced facilities to create space age products through modern metallurgy.

Here, new materials and processes are developed, and the problems pertaining to their fabrication in quantity are solved in the pilot plant facilities. Equipment includes vacuum- and atmosphere-induction furnaces, vacuum-arc melting furnaces, bell-type furnaces and special quenching facilities. Other metalworking facilities include heavy equipment for metal conditioning, forging, pressing and rolling. For precision parts or intricate shapes, facilities for skull-melting, investment casting and sintered metal processes are used.

Here again, Westinghouse offers a one-stop source for you — from design conception, materials engineering, pilot runs to finished part. Here is your guarantee that the finished product will be right at every step. Explore the Westinghouse world of new metals for your requirements for space age alloys.

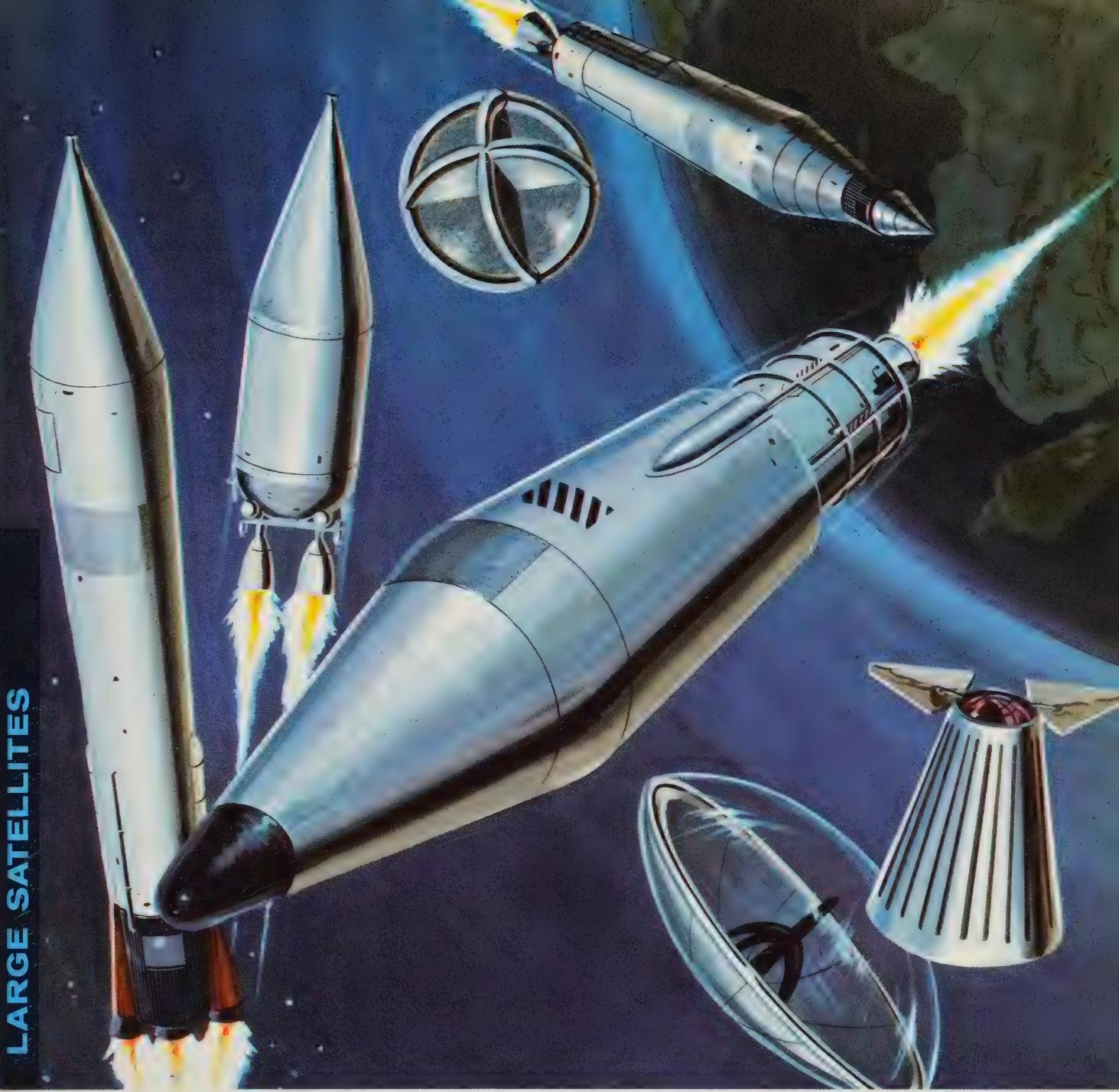
#### YOU CAN BE SURE...IF IT'S

# Westinghouse

*Illustrated, an inflated foil satellite, for global communications and TV broadcasting; an artist's impression of an observation satellite 'looking' at the world below; a larger radar corner reflector; a Discov-*

*er package containing a recoverable capsule and a Centaur flanked by the payload of a sister ship, moving fast on its fuel of liquid hydrogen. Closer to the earth is Score, the 'talking' Atlas-in-orbit which carried the President's message to the world.*

(Bottom, left:) observation satellite and communications satellite. • (bottom, right:) Score • (center:) Discoverer second stage • (center right:) corner reflector • (top:) Centaur, and Centaur second stage.



## SPACECRAFT U. S. A.

Look for these spacecraft in the banner headlines of tomorrow . . . look for them in the history books of the future. All these fantastic craft will affect the shape of things to come in the dawning space era. And Westinghouse will be a part of every flight. With a universe of research, development, and production facilities, Westinghouse contributes to every space mission. Sixty-one major manufacturing plants, 112,000 employees with 10,904 graduate engineers and scientists among them — this is the reality of Westinghouse today.

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1. two-man deep space ship
2. Thor-Hustler booster vehicle
3. radar reflector satellite
4. The X-15 — first piloted space-airplane
5. Scout satellite launcher
6. Vega satellite- and spaceprobe launcher
7. Dyna-Soar glide bomber
8. Pioneer I moon probe
9. reconnaissance satellite
10. Nova space ship booster
11. Pioneer IV moon probe
12. Discoverer second stage
13. Centaur second and third stage
14. Saturn booster configuration with Titan second stage
15. Venus probe with solar batteries mounted on paddles
16. 100-foot foil satellite for global communications
17. Mercury capsule for manned satellite.

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And power for the space age is yet another area of Westinghouse pioneering. Westinghouse leads the world in atomic power, which requires no oxygen, is equally at home below the surface of the sea, in the void of space, or on the surface of the moon. The new Westinghouse *astronuclear laboratory* will work exclusively on such nuclear energy applications for outer space projects.

Here are some nuclear power milestones already marked by Westinghouse products: the first atomic powerplant to produce useable power in quantity; the Nautilus, the world's first nuclear-driven submarine; the Skipjack, the world's fastest submarine; the George Washington, first Polaris-firing submarine; the Long Beach and the Enterprise, respectively the first nuclear powered cruiser and aircraft carrier. The Shippingport reactor for electricity is another show-piece of space age power from Westinghouse.

Other space era power sources will also come from Westinghouse. Look to Westinghouse for progress in thermoelectricity, propulsion concepts and systems. From the teamed efforts of the Westinghouse Atomic Power Organization, the Research Laboratories, the Aviation Gas Turbine Division, the Aircraft Equipment Department, the Astronautics Institute, the materials development facilities, and other creative Westinghouse groups will come new sources of power for craft and stations in space.

**YOU CAN BE SURE . . . IF IT'S**

# Westinghouse

*Shown: Atlas-Able and Thor Able—the slingshots which hurl small probes into deep space; and Scout, the prime mover of small satellites. Centaur, depicted separating its first and second stage, features a stage propelled by two rockets burning liquid hydrogen. Saturn is a tremendous eight-engine vehicle which develops a total of 1,300,000 lbs. of thrust in its first stage. Finally, there is Nova, the long-range hope of our space program. This monstrous rocket, more than four times as powerful as Saturn, may be able to return a 25,000 lb. payload from a Mars orbit.*

**Left to right:** Saturn • Atlas-Abie • Thor Able • Scout • Centaur • Nova



Now Man has dared to reach out into space and see for himself. Now his world has grown to include the whole solar system. This is the supreme adventure.

This is also the supreme test of the electronic components that help put him in space, and help bring him back again. Reliability, compactness, light weight become all-important. Reliability and creative design — these are the two hallmarks of missile, aircraft and spacecraft equipment created in the world of Westinghouse. Look to Westinghouse as the source for consistent reliability and best design for all these: amplifiers, electronic and magnetic capacitors, circuit breakers, coils, contactors, cores, electronic tubes, gyrospin motors, instruments, inverters, lamps, magnets, meters, motors, rectifiers, relays, semiconductors, switches, toroids and transformers.

The systems made up from these and other components are designed to capitalize on special qualities designed into each unit.

In addition, Westinghouse research work in the areas of high temperature electrical insulation, low-noise solid state microwave amplification, infrared, nuclear and high vacuum research has far-reaching applications in such system areas as propulsion systems, reconnaissance systems, space guidance and control systems. Of particular significance to the designers of sub-miniaturized electronic systems is a recent Westinghouse breakthrough in the method of semiconductor crystal "growth". This new development in molecular electronics may lead to the creation of outer-space equipment one thousand times smaller and lighter than anything now in existence.

**YOU CAN BE SURE...IF IT'S**

## Westinghouse

*Shown: The X-15, our first piloted space-airplane and the Dyna-Soar glide bomber, quickly darting out into the void before plunging back into the atmosphere; the Mercury capsule contains the first human-in-orbit. The Vega two-man capsule is seen as an artist's impression. The two-man spaceship with the long hull is headed for Mars or Venus — the other ship illustrated will be assembled while in orbit. The two-man re-entry capsules near the crew compartment are the launches of the space age, returning the travelers from the unknown seas to the familiar shores of earth.*

Clockwise: Vega capsule (7 o'clock) • Mercury capsule, (9 o'clock)  
 • Venus or Mars ship (12 o'clock) • X-15 (1 o'clock) • Dyna-  
 Soar, (3 o'clock) • deep-space ship, (5 o'clock)



## Solar system scanners . . .

Hurtling past the Moon, these spacecraft of today and the very near future are the unmanned renaissance craft of science. The great human voyages to Mars, Venus, Mercury, Saturn and Jupiter depend on what these robot explorers find — and do not find. Just like the space probes, Westinghouse shows the way to the worlds beyond our world. For the spacecraft launching sites of the Sixties, for the missile sites of today, Westinghouse equipment excels in all these functions: transports — traction motors and controls for electric trucks • erector equipment — drives and controls • electrical and electronic checkout systems — power supply, control center, transmitters, and instruments • launching devices — systems particularly suited to silo-type missile installations (underground or underwater silos may turn out to be the most practical arrangements for spacecraft cranes). A leader in shock-resistant equipment, Westinghouse is uniquely qualified to supply components for hardened military installations.

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*Illustrated, a Pioneer I type of Moon probe drifting along the Moon's surface, about to take a picture of its far side. The gold and blue cone is the Pioneer IV probe, headed for an orbit around the Sun. A Centaur second and third stage is racing past our view point in space, and an instrument pack is headed for a "soft" Moon landing, its descent slowed by downward-firing rockets. The alien structure coasting toward us is a NASA deep space probe, perhaps headed for Venus or Mars. The solar batteries positioned on paddles all around it are so arranged that one of them faces the Sun at all times; in this fashion, an eternal power supply permits continuous broadcasts back to the planet of*



CALENDAR

**October 20-21**—Hypervelocity Projection Techniques Conf., Denver Research Institute, University of Denver, Denver, Colo.

**October 20-22**—10th National Conference on Standards, American Standards Assn., Sheraton-Cadillac, Detroit, Mich. "Should American Industry Convert to Metric System?"

**October 26-28**—Sixth East Coast Conf., Baltimore Section, IRE, Professional Group on Aeronautical & Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md.

**October 26-28**—National Transportation Meeting, SAE, La Salle Hotel, Chicago, Ill.

**October 27-29**—Midwestern Meeting on New Frontiers in Aviation, IAS, Broadview Hotel, Wichita, Kansas.

**October 28-29**—Sixth Annual Computer Applications Symposium, Armour Research Foundation, Morrison Hotel, Chicago, Ill.

**October 28-30**—National Fuels & Lubricants Meetings, SAE, La Salle Hotel, Chicago, Ill.

**October 29-30**—Electron Devices Meeting, IRE, Professional Group on Electron Devices, Shoreham Hotel, Washington, D. C.

**November 2-4**—Annual Midwestern Meeting, Institute of Aeronautical Sciences, Lassen Hotel, Wichita, Kansas.

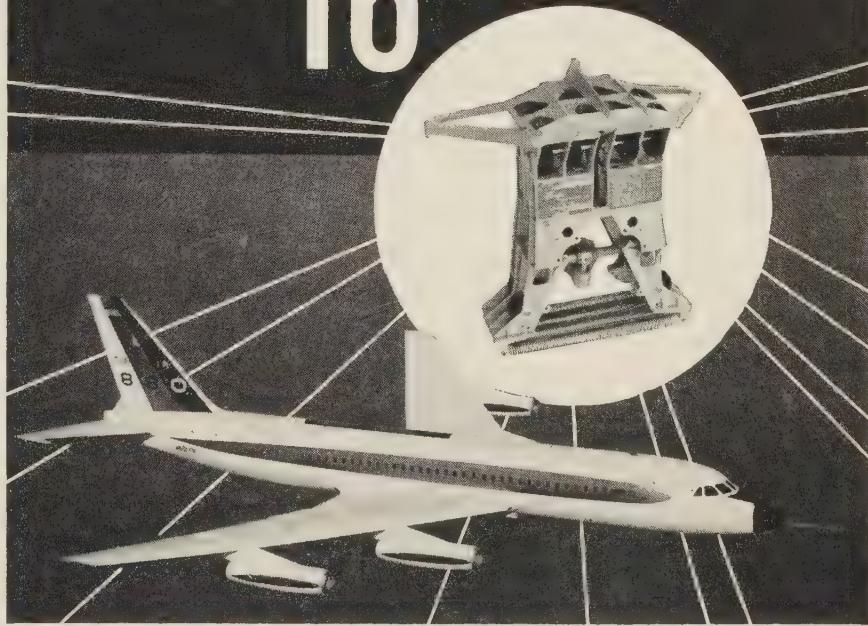
**November 2-6**—41st National Metal Exposition & Congress, American Society for Metals, International Amphitheatre, Chicago, Ill.

**November 3-5**—11th Annual Mid-American Electronics Conf., MAECON, Hotel Muehlebach, Kansas City, Miss.

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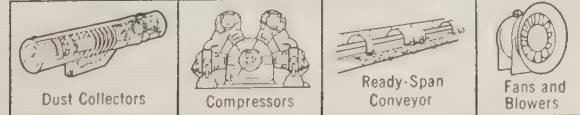
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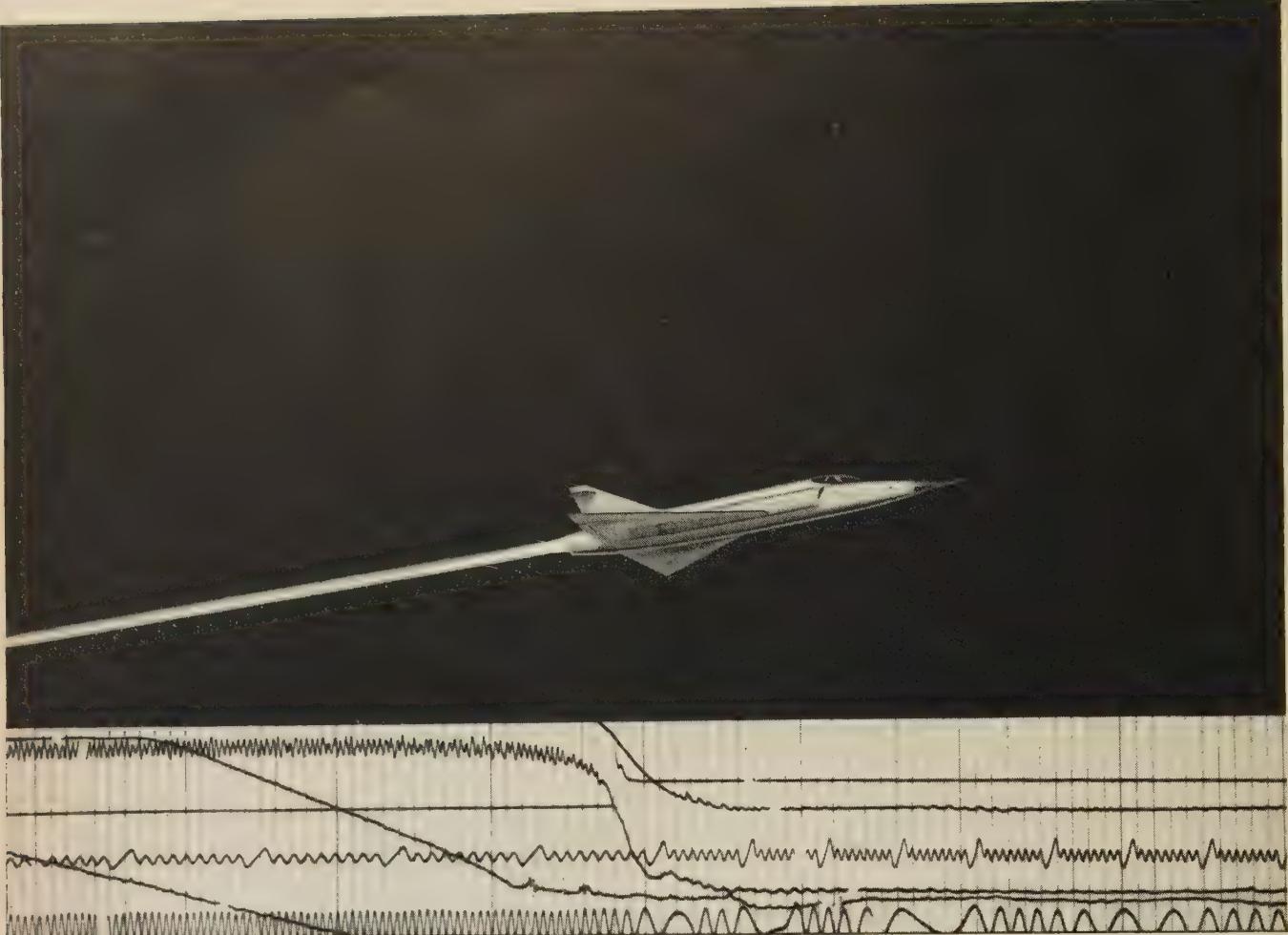


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SPACE/AERONAUTICS

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## ground support engineering



# Ground support engineering

## seeking true design yardsticks

*Better feedback from the field, clearer definitions, higher stature for GSE designers are still needed*

by Victor de Biasi, Associate Editor and Project Leader

**I**N TEN YEARS, one basic aspect of ground support equipment (GSE) design for aircraft and missiles has remained virtually unchanged: The men in the field, who must use the equipment, were bitter in 1949, and they are just as bitter today.

But this perhaps should not cause too much anxiety among the weapon system prime contractors. Those men in the field are pretty well resigned to their fate, and anyhow they have little say when it comes to either weapon or GSE development contracts.

What should worry the primes is that others are now growing restive about the entire subject of GSE—men who are much higher up on the military hierarchy. Something is wrong somewhere, these men reason, when GSE costs begin to rival and pass those of the vehicle itself. Many of these critics make no bones about whom they are blaming: The weapon system contractors, they charge, are more interested in making a healthy profit on GSE than in efficient (and therefore economical) design.

The primes will have to answer this criticism somehow. For, whether it is fully justified or not, it's what the customer is thinking.

In its interviews with military GSE specialists, SPACE/AERONAUTICS also heard grumblings that all the industry's talk about integrating GSE at high levels of vehicle development is just that—talk. True, many companies have set up special GSE design groups. But in the opinion of the military, that hasn't helped. The GSE group still operates as a separate entity, apart from the vehicle designers, and it doesn't have the stature to make its influence felt in design decisions affecting servicing and maintenance.

By and large, the military says, it hasn't seen any signs so far of advanced vehicles and GSE that the "corner garageman" could work with under field combat conditions. Most of the sophisticated GSE now in development, the military explains, is quite impressive and should prove effective—if you have the engineers and experienced technicians to run it. But all the military has is that "corner garageman."

These are problems management must resolve. As a starter, an industry group could be formed to assess present GSE designs and procedures. This group might poll men in the field to get their

*more on next page*

**A Space/Aeronautics special report on the state of the art and the technical outlook in one of the basic fields of aerospace engineering**



Vic de Biasi

**THIS SPECIAL REPORT** is intended to give our technical readers a detailed and yet comprehensive picture of the state of the art in ground support engineering and of the outlook for the future development of GSE. The response to the GSE report *SPACE/AERONAUTICS* published last year clearly showed that such an information package was badly needed as a reference by both prime contractors and GSE designers—and here it is, in a new, up-to-date edition.

The planning for this special report began well over six months ago—as soon as it had become apparent that the rapid pace of GSE progress was threatening to make last year's report obsolete. The job of producing the report was turned over to an editorial team consisting of Irwin Stambler, Jim Holahan, Bern Kovit, and Bob Loebelson, and headed by Vic de Biasi.

Expert contributors were enlisted to deal with specialized GSE problems from base hardening to nuclear servicing. Two special surveys were run, covering about 40 prime and over 1500 subsystem contractors, to get a reliable and detailed account of the industry's GSE capabilities.

S/A's special report begins with this article. The other features of the report are:

How the Military Funds and Programs GSE	54
GSE and Vehicle Must Be Closely Integrated	56
Railway Launching for Mobile ICBMs . . . . .	59
Shock-Proofing for Hardened Bases . . . . .	62
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A limited number of reprints of this report is available at \$1 per copy. Reduced rates apply for bulk orders of 50 copies or more. Address orders and remittance (no stamps, please) to: Reprint Dept., *SPACE/AERONAUTICS*, 205 E. 42nd St., New York 17, N.Y.

*Randolph Hawthorne*

Editor

criticisms, invite maintenance and R&D groups in the military to contribute their ideas, and work up reliable figures for GSE development cycles and costs as related to R&D and production programs.

Some of the plentiful misunderstandings about GSE can be traced back to the fact that not very many people agree on any definition of GSE—neither on what the term actually means today nor on what it should mean. The official definition that makes the best sense is the Air Force's, which says GSE consists of ground operations, handling, and servicing equipment. In short, everything maintenance and crew men need to ready a missile or plane for flight and get it into the air.

The Army treats a weapon system as a package separated into a weapon and ground control equipment (GCE). GCE includes what the Air Force calls GSE (i.e., all handling and servicing equipment) and much more—it also takes in surveillance and tracking radars, combat information centers, data link systems, and so on. Each of these latter control systems of course needs its own support equipment, which naturally stays on the ground and therefore figures as GSE.

The Navy "defines" GSE by subdivision: "general support equipment" can be used for more than one vehicle or engine (e.g., hydraulic test stands, tow bars, jacks, etc.); "special support equipment" is designed for a single system (adapters, custom-tailored automatic checkout gear, fixtures, etc.); and "standard support equipment" covers such things as machine and hand tools, plating equipment, voltmeters, etc.).

It is easy to draw a clear-cut line for operational, or tactical GSE. The real trouble starts when you turn to GSE for R&D programs. Some people do not know where to classify flight test facilities like telemetry stations, tracking cameras, antenna installations, etc. This equipment, all of which has its own support equipment, is a necessary part of the ground flight test setup. But it is not developed or bought with GSE funds. Nor is it designed or developed by GSE engineers.

### DOD changed its budget structure

This year the Department of Defense made some changes in its budget structure to show more clearly what is being spent on GSE funds. The Air Force's missile and aircraft procurement estimates for fiscal 1960 are broken down into three general categories: (1) funds for missile or aircraft procurement and production, (2) funds for ground support equipment, and (3) funds for development, test, and evaluation support. In the third category, it is estimated about 15 per cent of the money goes for GSE.

As several hundred million dollars may be spent on the development, test, and evaluation of a single weapon system, the 15 per cent for GSE becomes quite a lot. For example, the Air Force in its 1959 budget asked for \$203.5 million just for the B-70 development program alone. Included was \$25.6 million, or about 12½ per cent, for initial development of ground support and training equipment. It's expected this percentage will increase once the B-70 reaches the prototype hardware stage.

Better funding control, of course, will not insure better GSE. But more feedback from maintenance and service men in the field will. In many GSE designs, the practical problems of maintenance and service are still being neglected. This situation is so grave that serious consideration is being given to the idea of asking con-

tractors to let field or maintenance engineers participate in the development of original designs. Any conflict between these advisers from the field and the actual designer could be resolved by the systems manager.

Naturally everyone admits that it doesn't make sense to subordinate the weapon to its GSE if that means compromising the performance specs. However, some vehicle designers use this performance priority to cover up their neglect of GSE features. They also figure that no one will discover their mistakes until the equipment gets out into the field. By that time, it is too late to modify the vehicle for easier servicing or change the GSE. The one who is really stuck with the problem is the maintenance man.

At an American Rocket Society conference in Daytona, Fla., last March, Martin's Warren F. Opitz proposed that, early in a missile design program, it should be decided exactly what is to be seen by the GSE when it looks into the missile. For automated checkout, Opitz suggested as an example, test voltages should be limited and standardized so that only a single set of voltages would be permitted at the GSE and airborne interface—and this limit should be observed throughout all changes in the airborne equipment.

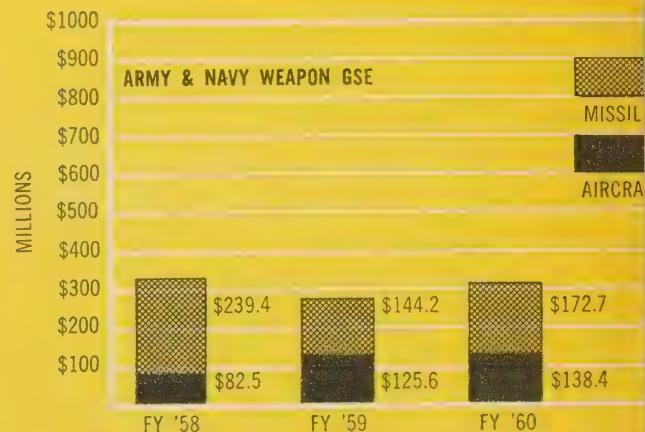
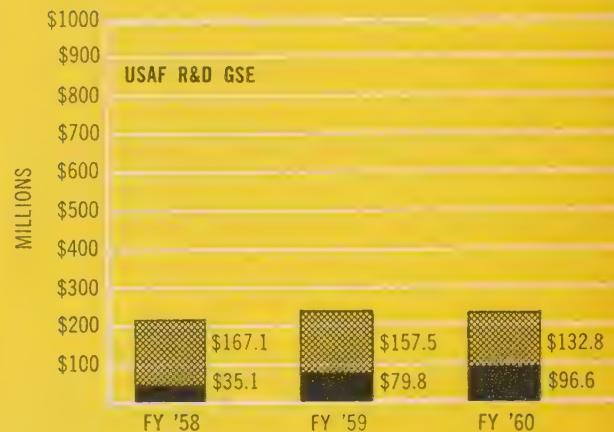
### Changes increase on the way to GSE

The way it is now, a simple design change in the airborne system can easily lead to a ten times bigger change in the GSE system. On the Atlas, Opitz pointed out, a relatively simple missile design change became necessary that was put through in 3-4 weeks. Then it took 3-4 months to modify the GSE checkout system to make it compatible.

Right now, GSE design is going through a shakedown period—after rather haphazard beginnings it is rapidly developing into a major engineering speciality that plays a vital role in overall weapon development. The increase in unique GSE items for major weapon systems is clearly shown by the listing of "Current GSE Systems and

*more on next page*

**SERGEANT LAUNCHER** is designed around an adjustable parallelogram structure whose shape can be changed to erect or lower the missile.



**RISING ALLOCATIONS** show growing importance of GSE in our defense effort. Figures for weapon GSE cover both operational and new types and are taken directly from budgets for USAF and extrapolated from budgets for Army and Navy. As necessary, they are adjusted to the new budget structure put into effect this year. R&D GSE figures are based on the rule of thumb that 15 per cent of all money spent for development, test, and evaluation goes for GSE.

Table I: GSE Production Prototype Costs (per cent of new vehicle development cost)

Vehicle	Mechanical GSE	Electronic GSE
<b>AIRCRAFT &amp; DRONES</b>		
Target drone	5%	5%
Surveillance drone	5%	10%
Mach 2 bomber	5%	10%
Mach 3 fighter	5%	10%
Mach 3 bomber	10%	15%
Nuclear Aircraft	25%	15%
<b>NON-BALLISTIC MISSILES</b>		
Air-to-air	5%	5%
Air-to-ground	5%	10%
Ground-to-air	10%	15%
Ground-to-ground	10%	15%
Ship-to-air	15%	10%
<b>BALLISTIC MISSILES</b>		
Tactical liquid	20%	20%
Tactical solid	10%	15%
Strategic liquid	20%	25%
Hardened-base liquid	35%	25%
Hardened-base solid	20%	25%
Mobile strategic solid	20%	30%

Subsystems" (p. 79), based on a special SPACE/AERONAUTICS survey. There is a lot less specialized GSE used for the F-100 fighters, for instance, than for the B-58 or X-15.

#### Military pushing "common" designs

This current shakedown period is marked by three important GSE trends:

- *More Universal GSE Items*—The military intensely dislikes having to buy a raft of special GSE for every new weapon system, so it is pushing the development of multisystem, or universal, GSE. The Air Force has competitive bids out for a "common programmer" to be used in subsystem tests and checkouts on both aircraft and missiles. The Navy has bids out for a "common launcher" to be used for a whole family of missiles. The Army, too, intends to get away from tailored checkout and test systems, and has already contracted with RCA and Northrop for the development of multi-purpose automatic test equipment for missile systems.

- *Independent GSE Developments*—Stress is being put on separate engineering proposals for advanced GSE systems such as will be needed for manned space vehicles. These proposals are to include estimates of engineering manhour, production costs, special facility costs, and field test evaluation costs. In effect, GSE for the newer and more complex R&D programs is being raised to the major-system level.

- *Pioneer GSE Designs*—Several new design ideas have been developed in the last year that are setting the pace for future GSE systems, among them continuously operating automatic checkout, monitoring, and

countdown GSE for Atlas, Titan, and Minuteman bases; preliminary mobile IRBM and ICBM launchers; and GSE hardware for experimental airborne nuclear reactors.

Asked by SPACE/AERONAUTICS to pick out the most important GSE design problems of the immediate future, engineers throughout the industry most consistently listed the development of GSE for hardened bases, mobile ICBMs, nuclear vehicles, and spacecraft.

The special parameter of *hardened-base design* are air blast, ground shock, and nuclear and thermal radiation. A nuclear explosion sends out traveling shock waves of compressed air that subject ground objects to static overpressure (compressed air) and dynamic pressure (moving air). The static overpressure governs the design of flush installations, while the dynamic pressure must also be considered in the design of above-ground installations.

#### Blast waves attenuated with depth

Both air and ground blasts produce ground shock waves that are transmitted through the earth's structure as acceleration and displacement forces. Both types of forces are attenuated with depth. Sandy soil does a better job of damping the acceleration forces, while hard rock absorbs quite a bit of the displacement forces.

One of the big problems in hardened-base design is predicting how the site will respond to the shock waves. Analytic solutions are quite complex and often unsatisfactory—it's too difficult to foresee the interaction of the earth's many strata. Even with a liberal number of core samples taken at and near the site, it is next

to impossible to get an accurate picture of earth conditions.

However, progress is being made on empirical solutions. In one of these, you simulate the site conditions, set up a series of spring mass systems (to represent the hardened-base equipment), touch off a small blast, and measure the resulting forces. A series of load-frequency curves from the recorded data yields the shock isolation requirements (see "Shock-Proofing of Hardened Missile Bases," p. 62).

### Good results with empirical method

Obviously, this technique is inexact, since the actual site response will be different. Nevertheless, the results have been quite good. (Anyhow, the only alternative technique is a bit staggering: instrument your site, drop an atom bomb on it, and measure the effects. You now have unsurpassably accurate data and a ruined site.)

Nuclear and thermal radiations are lesser problems. Gamma and neutron radiations must be expected for 60 seconds after detonation. If the base structure is designed to withstand them, subsequent fallout is no problem. One of the advantages of underground installations is that the earth is about as good a radiation shield as a concrete wall.

Many proposals have been discussed recently for mobile ICBM's to be launched from trucks, railroad cars, inland waterway barges, and surface vessels. Most of these represent logical extensions of the submarine-launched Polaris design. The combination of large solid propellant rockets or large, storable liquid propellant packages with smaller and higher-yield nuclear warheads makes the mobile ICBM a practical possibility. Minuteman, for example, will be fired from mobile launchers as well as from concrete-lined silos.

### Tube launching proved by Polaris

The most practical designs so far seem to be the railroad and surface-vessel launchers. Aboard ships, Minuteman could be launched from a Polaris-type tube. Several successful Polaris test firings have already shown that tube launching is feasible. Railroad launchings should be no less feasible. The basic problem in that case is to keep the mechanical design simple (see "Railway Launching for Mobile ICBMs," p. 59).

The most formidable problem facing the GSE engineer is the development of mechanical handling equipment for *nuclear aircraft and missiles*. This GSE really will have to be integrated with the vehicle design from the very start. This may lead to such new design features as housing devices (in the form of alignment slots and locating pins); combined hydraulic, pneumatic, and electric umbilical plugs and receptacles; shielding tricks such as zig-zag and helical conduits to carry tubing, wiring, and mechanical actuators through shielding structures; six-degree-of-freedom remote-control manipulators, sensitive enough to provide feedback to human operators; etc.

*Spacecraft GSE* runs a close second to nuclear GSE in complexity. The chief problems lie in the development of giant mechanical equipment to handle, erect, and launch outsize multistage vehicles; automatic fueling and defueling systems for exotic propellants like liquid fluorine and liquid hydrogen; pilot capsule servicing techniques; launch monitoring systems; etc.—End

## BuAer Tips for GSE Design Engineers

### Plan Your Design Approach:

Analyze carefully the job your equipment must do

Determine the requirements your equipment must meet and the restrictions to which it must conform

Determine the operational conditions

Determine the weapon component character

### Allow for Human Characteristics:

Capacity                      Intelligence

Mobility                      Common skills

Strength                      Learning ability

Body dimensions

### Provide These Design Characteristics:

Low silhouette

Operation at any angle up to 30 deg from the horizontal

Resistance to 160 db weapon noise

Grouped controls

Doors that can be held open in winds of up to 70 mph

Hoist attachments

### Observe These Design Parameters:

Size—180x72x54 in. Clearance—8 in.

Weight—4000 lb              Lifting—by sling

Noise—75 db at 30 ft      Movement—by

Life—2000 hours              hand-vehicle

Fuel—8 hours

### Provide These Maintenance Features:

Grouped calibration check points

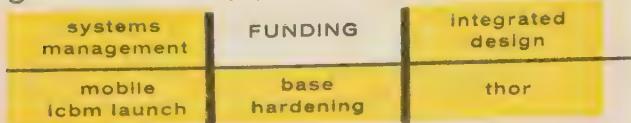
Units replaceable without major disassembly

Removal access to all internal components

Component replacement in 20-30 minutes

Minimum size differences among screws, bolts, and disconnects

Removable control and valve body housings



## How the military funds and programs GSE

- Market analysis must rely on informed guesses
- Air Force pushing hard for standardization
- High ratio of GSE in missile development

by Robert M. Loebelson, Associate Editor

**J**UST HOW MUCH goes for ground support equipment out of the roughly 40 billion dollars we now spend each year on defense? Well, no one really knows—no one in the Department of Defense and no one in the industry. All that the military's fiscal experts can tell you for sure is that the figures for GSE spending already run into the hundreds of millions and that they will keep on rising as missiles take a larger slice of the defense dollar.

The trouble is that DOD bookkeeping does not cover GSE as such. DOD and each of the services keep tabs on the cost of individual weapon systems. They know precisely how much is spent on a given weapon in a given year, but this figure covers everything—the airplane or missile itself and all its ground and airborne equipment.

Market researchers in the aerospace industry therefore have been foiled again and again in their attempts to fix the potential GSE market. The best anyone seems to be able to come up with is an informed guess. The following data represent SPACE/AERONAUTICS' informed guess, based on interviews with fiscal experts at Air Material Command Headquarters in Dayton, Ohio, at DOD and service levels in the Pentagon, and on a detailed analysis of past and present budget documents.

The Air Force, in its "Aircraft Procurement" ac-

count, shows \$212.9 million for GSE in fiscal 1960, as against \$313.9 million last year and \$175.5 million in fiscal 1958. Additional sums in the same account, covering development, test, and evaluation support, total \$644 million for fiscal 1960 vs. \$531.6 million last year and \$233.9 million in fiscal 1958.

USAF's "Missile Procurement" account shows \$642.5 million for GSE this year, as against \$688.5 million in fiscal 1959 and \$403.7 million in fiscal 1958. The sums covering development, test, and evaluation support under "Missile Procurement" are \$885.2 million in fiscal 1960, \$1 billion in fiscal 1959, and \$1.1 billion in fiscal 1958.

In USAF's third major buying category, "Other Procurement," the sums for ground support equipment are:

- *Electronic Weapon Support Equipment*—\$410,000,000 for fiscal 1958, \$652,000,000 for fiscal 1959, and \$778,500,000 for fiscal 1956;
- *Telecommunication Equipment*—\$61,000,000 for fiscal 1958, \$140,000,000 for fiscal 1959, and \$149,200,000 for fiscal 1960;
- *Other Base Maintenance and Support Equipment*—\$144,700,000 for fiscal 1958, \$150,400,000 for fiscal 1959, and \$140,400,000 for fiscal 1960;
- *Development, Test, and Evaluation Support*—\$78,000,000 for fiscal 1958, \$52,500,000 for fiscal 1959, and \$33,500,000 for fiscal 1960.

### Much of R&D money goes for GSE

In addition, USAF's "Research, Development, Test and Evaluation" program (formerly known as the R&D account) totals \$1.1 billion this year, as against \$1 billion in FY 1959 and \$0.928 billion in 1958. This R&D money covers several categories, but there is little doubt that a substantial percentage (perhaps as much as a half) covers GSE research of all types.

In view of the large sums now involved in GSE, the Air Force is trying to standardize existing and planned GSE as much as possible. One attempt in this direction

is being made by AMC Headquarters, which is compiling a handbook of technical information on GSE end items (with the help of the various USAF depots and Air Materiel Areas and the AMC Aeronautical Systems and Ballistic Missiles Centers).

This "Technical Information File" is broken down into 16 major GSE categories and scores of sub-categories. It covers end items costing \$2000 or more apiece and items with an actual or potential annual procurement total of to \$100,000 or more.

### Central source of information

The GSE "Technical Information File" will be a continually updated compilation of technical data sheets on the various types of GSE in existence or under development. As a central source of information on GSE that is already available, USAF hopes, it will cut down on the amount of GSE specially designed for new weapon systems.

One big reason why the Air Force is so interested in standardizing on GSE lies in the shift of emphasis from aircraft to missiles. A missile needs more GSE than an aircraft—even though today's aircraft themselves need much more GSE than their predecessors of a few years ago.

In fiscal 1960, for example, USAF plans to spend \$3.96 billion on aircraft. The same year's GSE figures, as we've already noted, include \$212.9 million for the aircraft themselves and \$644 million for aircraft development, test, and evaluation support. The ratio between the \$3.96 billion figure for aircraft and the GSE total of \$0.8569 billion is roughly 4.62.

By contrast, AF's fiscal 1960 budget shows \$1.2 billion for missile procurement and production, \$642.5 million for missile GSE, and \$885.2 million for GSE for development, test, and evaluation support. The ratio of the \$1.2 billion for missiles to the GSE total of \$1.5277 billion is roughly 0.79—in other words, the Air Force right now is spending over 25 per cent more on missile GSE of all kinds than on missiles themselves.

### Substantial Navy funds for GSE

The Navy breaks down its budget somewhat differently than USAF, but the ratios of GSE to aircraft and missiles are about the same for both services. BuAer is programming \$1.67 billion for planes and related equipment, \$113 million for missiles and drones and related equipment, \$30 million for training equipment, \$33.8 million for ground electronics and detection equipment, and \$107.9 million for development, test, and evaluation support. Obviously, a substantial segment of BuAer's fiscal 1960 budget will go for GSE. The same holds for BuOrd's budget, which lists \$320.1 million for missiles and another \$159.6 for development, test, and evaluation support.

Still more sums covering Navy GSE procurement show up in the Marine Corps' fiscal 1960 program. The Marines will buy \$46 million worth of guided missiles and related equipment, \$35 million worth of communications and electronics equipment, and will spend \$12.3 million for development, test, and evaluation support.

The Army's fiscal 1960 program shows \$81 million for planes and \$407 million for guided missiles. In addition, \$191 million is to be spent on communications and surveillance equipment—so the Army, too, is a prime target for GSE marketers.—End

## Industry Figures on GSE Production

SINCE it seems to be a prime characteristic of GSE market figures that they turn up in the most unlikely places, it's not so surprising that it should have been a Labor Department project that resulted in one of the best sets of figures yet on actual GSE production. The Labor Department, it seems, some time ago began to wonder whether it shouldn't overhaul its definition for what it calls the "aircraft industry." (It should.) So it asked the Department of Defense to run some surveys of aerospace contractors to find out just what kind of work these contractors are doing now.

DOD just completed two such surveys—one of over 90 leading missile contractors and another of over 115 electronics firms, the latter covering work on equipment for aircraft. The results of these surveys are not conclusive in every respect—the scope of the surveys was somewhat restricted, and the contractors that were covered had considerable trouble categorizing their work in detail. However, in the case of GSE, the surveys provided quite an interesting picture of the distribution of emphasis and the changes in business over the last two years.

The survey of the leading missile contractors showed the following figures for missile GSE production:

- *Electronic Equipment*—\$594,100,000 in fiscal 1958 and \$553,100,000 in fiscal 1959.
- *Stationary Launching Platforms*—\$138,800,000 in fiscal 1958 and \$148,000,000 in fiscal 1959;
- *Mobile Launching Platforms*—\$16,000,000 in fiscal 1958 and \$12,900,000 in fiscal 1959;
- *Cranes, Trucks and Other Handling Equipment*—\$20,400,000 in fiscal 1958 and 12,400,000 in fiscal 1959;
- *Fueling Equipment*—\$6,300,000 in fiscal 1958 and \$7,400,000 in fiscal 1959.

The survey of electronics contractors led to these figures for electronic aircraft GSE production:

- *Total*—\$77,700,000 in fiscal 1958 and \$150,700,000 in fiscal 1959;
- *Special-Purpose Equipment*—\$66,400,000 in fiscal 1958 and \$135,300,000 in fiscal 1959.

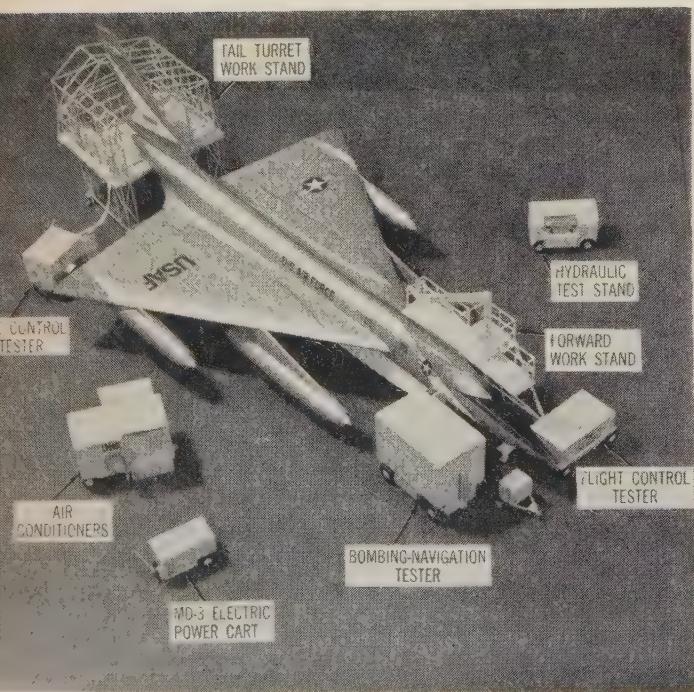
systems management	funding	INTEGRATED DESIGN
mobile icbm launch	base hardening	thor

# GSE and vehicle

must be closely integrated

- Handling facilities limit missile size and weight
- Test points must favor efficient GSE hookups
- Interface problems call for close team work

by Irwin Stambler, Associate Editor



THE IMPORTANCE of GSE in basic system design gets you back to the old riddle, "Which came first, the chicken or the egg?" A few years ago, there was little question about this in the vehicle designer's mind—he churned out the plans for his aircraft or missile with little or no worry about GSE. It was up to the GSE supplier to find a way of tying his gear into the existing system. Of course, until recently, only a few pieces of relatively simple GSE were needed.

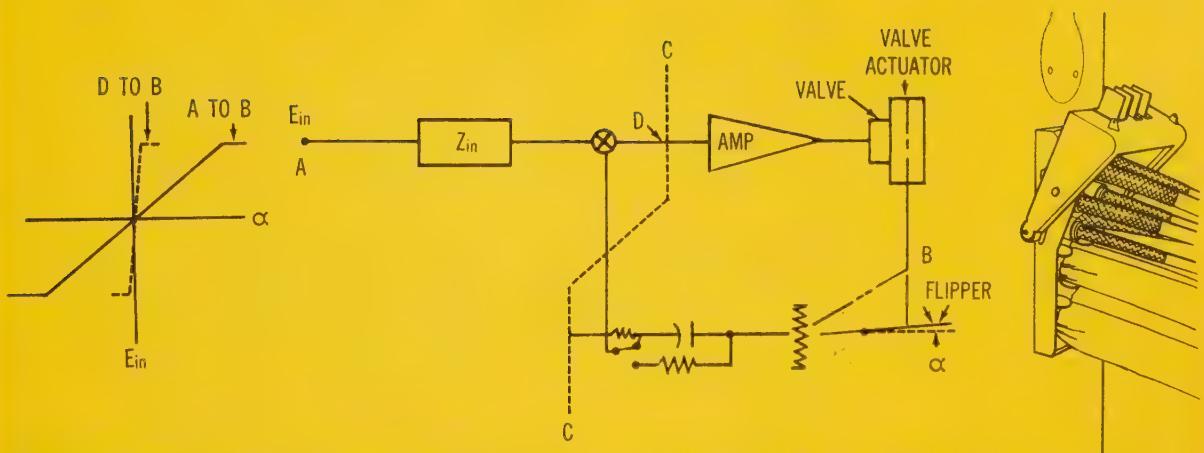
Today, there is an unmistakable new trend. GSE considerations are coming into play right from the beginning of a new design. In fact, in some areas, GSE sets the major limitations on overall vehicle design.

A good example is missile size. A bird with a diameter of over 13 ft, researchers at Space Technology Laboratories told SPACE/AERONAUTICS, couldn't be transported on our present rail and highway systems. (A possible out would be to build the vehicle at the launch site, which of course would raise many problems and require added equipment.)

Transportation limitations also affect the weight of large vehicles. Scientific, one-of-a-kind designs can be hauled around the country even if they weigh as much as 500,000 lb. However, there are only about 10-12 railroad cars in the country that can handle so big a load. Half a million pounds also greatly exceeds the capacity of a good part of the highway system.

For tactical missiles, transportation factors would seem to limit gross weight. With present handling

**B-58** GSE equipment, shown in typical arrangement for simultaneous testing of several systems, was integrated into the overall design from the beginning. Plane modifications prompted by GSE considerations include swinging tail turret and extra circuits in airborne electronics for ground test.



**CONTROL SYSTEM** diagram (center) shows why the ground test engineer must make sure the vehicle's systems are properly packaged. If a test signal is fed in at A, the response is easily measured at B. However, if the parts of the system are widely scattered, say, along line C, testing becomes very difficult. As the graph shows, if the signal is fed in at D, intermediate values of  $\alpha$  can't be measured because of

the high gain in the amplifier—with the system in the saturation condition, the flipper will go hard to one side or the other. Right: Compact single umbilical line like this unit designed by Food Machinery & Chemical may add some weight but provides an overall advantage by sharply reducing the complexity of the launch operation and so the launch time.

equipment, including air transport, the weight limitations for tactical missiles are quite a bit below 500,000 lb—probably 100-150,000 lb at the very most for a single unit.

Propellants and propellant handling equipment, also have major effects on vehicle design. For instance, one fuel might provide the highest specific impulse but also require much more expensive handling and storage facilities than another, less efficient fuel. It also might be much more dangerous to handle. Such factors might force a 10-20 per cent reduction in  $I_{sp}$  in favor of the second fuel.

### Silo size might limit missiles

Another example of the major effect of ground support on basic missile design is the present "hole-in-the-ground" launch site approach. The question here is how much growth to allow for in the design of these "silos". If a lot of silos are built, the bricks and mortar used in making the holes obviously aren't changeable. So if, in the future, it was decided to build improved versions of missiles using these sites, missile size would be limited by silo size. One solution would be to add an extra length of framework to the top of the hole, but this would be costly and also might not permit the most efficient improvement in vehicle shape.

The trend toward increased integration of GSE into the overall system is perhaps best shown by manned vehicles. Convair engineers pointed out to SPACE/AERONAUTICS that, while GSE costs increased by a factor of 10 from the B-24 to the F-102, they increased another factor of 10 with the F-106—just in pro-

gressing from one advanced performance craft to an improved but still very similar design, the effects of GSE on the vehicle increased perceptibly. The main reason was the use of more sophisticated fire control equipment in the F-106.

The direct effect of GSE on basic vehicle design are still modest in the F-106. However, in the basic design setup, the GSE section became a major floor group—just as important as the wing group, the powerplant group, etc. In particular, the airplane power lead man and ground power lead man are located physically near each other to insure close liaison on interface problems.

With higher performance craft, the trend towards greater GSE effects on vehicle design is marked. As C. R. Curnutt, assistant project engineer on the B-58 at Convair-Ft. Worth told SPACE/AERONAUTICS, it's now hard to say where the plane effects GSE and vice versa.

### GSE determined B-58 tail turret

The B-58, for instance, has a swinging tail turret design that was chosen entirely for ground servicing reasons. It exposes the surfaces of electronic equipment in one direction and the ammunition loading area in the other. The B-58 pod has provisions for running hoisting cables right through the body of the plane. This design, states Curnutt, permits a more efficient ground support arrangement by eliminating lifting gear in the pod cart.

From the beginning, careful provision was made for test procedures. Suppliers were requested to include

more on next page

test points in airborne gear that could be used both while the equipment was in the plane and on the bench. Some of these points are used only when the equipment is on the bench.

In the basic circuit design of airborne equipment, test wires were included to obtain voltages for use in GSE voltage comparators. This step affected the way in which the voltage pickoffs were made. In most cases, the pickoffs ran into high impedance loads. It was necessary to closely check the routing of the wires to prevent extraneous signals.

At first glance, it might be thought that in detail design, particularly on high performance missiles, GSE considerations that might add even a slight amount of weight to the vehicle would be overruled. In general, this is true. However, there are many factors that might throw the decision in favor of GSE in some cases.

One example is the major load patterns carried by the missile and launcher in such designs as IRBMs and ICBMs. The in-flight loads, Space Technology Laboratory engineers note, are mostly compressive. But from a GSE standpoint, it's necessary to handle the design in tension.

If the GSE complex were designed only for airborne loads, you might end up with a monstrosity of a launcher. For instance, it might be desirable to support the missile right at the point where the thrust load is applied (in a case, say, in which the missile is held down until the right dynamic pressure is obtained). From the spring constant rule, this approach might seem best, but it could result in a complicated launcher with a great many arms, complex mechanisms, etc. So it's better to take a small weight penalty on the missile to get a workable launch design.

On larger missiles like Atlas, Thor, Jupiter, etc., the umbilicals must be located so that towers can pull aside and swing away in launch. If the umbilical connections were all in the best possible places from a missile design standpoint, you might be forced to build

half a dozen towers or more. Instead, these connections are grouped in one assembly requiring a single disconnect point. This also improves reliability, since now there's only one tower. However, it adds some weight to the missile, since internal leads must be run to connect distant equipment to the single umbilical point.

Particularly tricky, missile designers state, are the interface problems between missile and GSE. The basic structural attachments and system connections must be precisely designed to fit or have the right adjustments to take deflections and the like. Mistakes in this area can result in additional critical deflections or fouling up of the lines during launch.

This design area usually involves mechanisms and close tolerances. Moving mechanisms are always extremely critical, since dynamic and inertial effects can affect the loads in unpredictable ways. Close integration of GSE and vehicle design is needed, particularly for heavy launchers involving rotating and moving equipment. You must also tread carefully in making improvement changes, designers state—your objective may be valid, but functionally you can get into more trouble than you were in with the earlier design.

In smaller missiles, too, increasing sophistication is increasing the effect of GSE on the basic design. At Convair-Pomona, for instance, the GSE group has had a major say in advanced Terrier and Tartar design right from the R&D stage. In preliminary design, a logistic study of flow through the organization is made so that all parties concerned know the ground rules about how the various assemblies line up. The GSE group specifies how the missile will be tested.

### Test points carefully selected

Throughout the design, Convair-Pomona GSE engineers told SPACE/AERONAUTICS, they have the responsibility of keeping close tabs on the overall design to insure compatibility with test needs. Such a procedure, it's claimed, makes certain that, when the missile reaches production, it can be properly checked out.

For instance, the GSE group checks to see that the designer doesn't widely separate parts of the same control system. Unless all the parts of the servo system are placed together, the group's engineers note, it is impossible to test control action properly. The group must also make sure that enough test points are provided in the correct locations.

The system test people, it's stated, often get to know the overall system better than any individual design group. As a result, in one case the airborne servo equipment design was drastically changed, GSE engineers say, because test equipment people pointed out a simpler way of doing it.

Service studies indicate that companies that don't have this close integration of GSE and vehicle design can get into difficulties. One company, it's reported, had 30 black boxes tied into a system designed by one division but produced by another division. The producing division was charged with building the test equipment for the completed design. As a result, it was possible to check out the missile in two hours, but if a failure was discovered, it took up to five days to trace it.

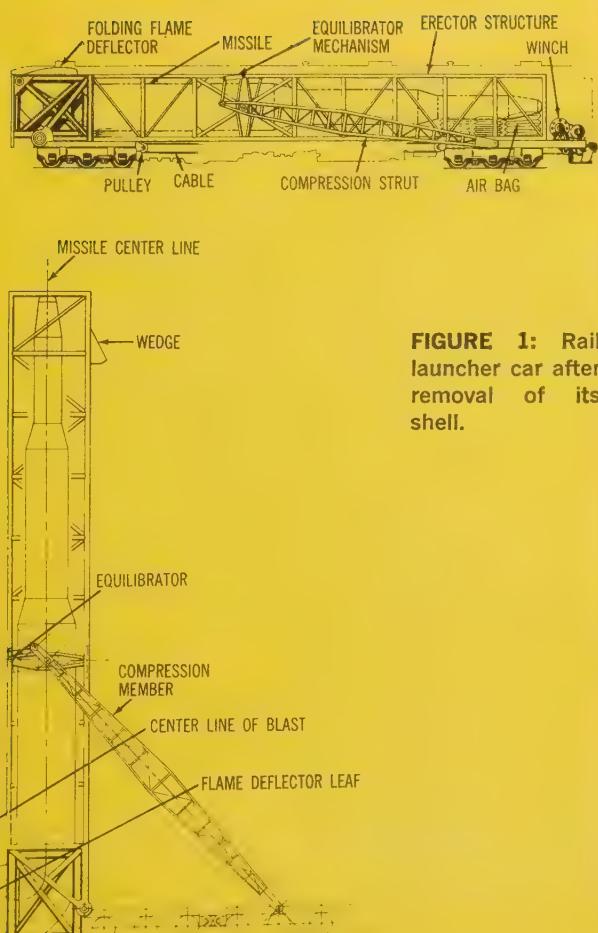
Naturally GSE has not become the controlling factor in vehicle design. Whenever possible, GSE-vehicle problems must be decided in favor of the vehicle. However, the results can be disastrous if GSE is not included as a prime factor in the overall system approach.—End



**RAPID TREND** towards increased mobility of missiles in the 10,000-lb-and-under class, shown by such designs as the Army's Hawk, call for precise integration of missile and GSE. Prime contractor for Hawk is Raytheon; handling system is designed by Nortronics.

# Railway launching

## for mobile ICBMs



**FIGURE 1:** Rail launcher car after removal of its shell.

- New type of rail car is needed for launchers
- Missile erection would be simple, reliable
- Entire car could be produced for \$200,000

by Michael L. Mastracci, Project Engineering Supervisor, American Machine & Foundry Co.\*

**T**HE design of an effective rail-mounted missile launcher can go very easily beyond the normal limits of the transportation art. The typical design approach so far has been to mount a conventional missile erector on a standard freight or flat car.

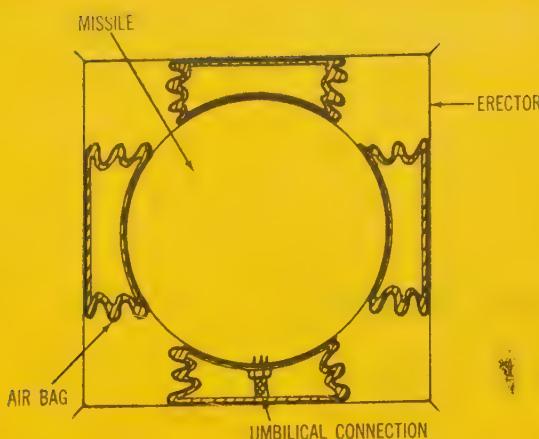
This is perfectly feasible for missiles in the 50,000-lb weight range. But for the large-warhead ICBMs of 100,000 lb or more, this method holds little promise. Internal space constrictions, missile fragility and the great missile mass generally combine to lead a complex and inefficient launcher-erector mechanism.

A standard six-wheel railroad truck can support 50 tons. This means a rail car with three such trucks can carry a gross load of 150 tons. A missile weighing over 75 tons leaves the launcher engineer very little design margin.

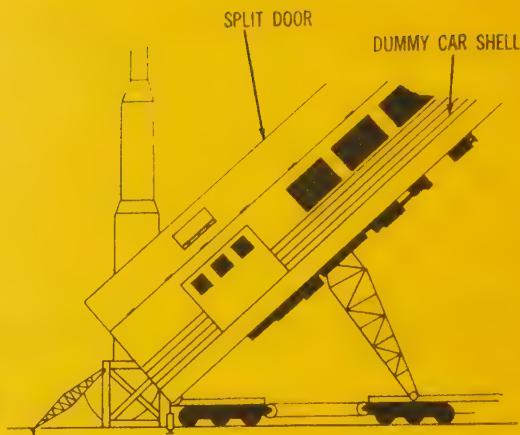
This fact forces you to go to a rail car based on an aircraft-type lightweight design. The limited weight bud-

\*American Machine & Foundry Co., Greenwich, Conn. Patent rights have been applied for on the concepts described in this article.

more on next page



**FIGURE 2:** Rail launcher for solid propellant ICBM in the firing position (right). The proposed \$200,000 launcher uses standard parts and design methods, and is of standard size



and gage. Its trucks use conventional running gear. Left: Detail of air bag support system, including cross-sections of missile and erector.

yet has to include the basic launcher car, long, wide-opening doors and associated mechanisms, a blast deflector, and of course the complete launcher-erector.

A new design approach therefore is in order. The idea of installing an erector mechanism on a standard rail car means one or both of these structures must be redundant. Also, the need for opening the complete car roof, common to most current designs, precludes the use of the car skin as load-carrying structure. Finally, the roof-open designs have very poor resistance to rocket blast effects—the vertical side walls and yawning doors make a perfect trap for the high speed exhaust gases.

The conventional way of designing rail cars has to be appraised in the light of the needs of missile launching. For instance, the car is not going to see standard railway operation. The launcher car doesn't have to be subjected to 400-ton coupling loads or rough handling. Without such restrictions, a lighter, very mobile railroad system is possible.

#### Missile could be made more rugged

At the same time, the airframe designer might think of a more rugged missile, which would help eliminate heavy strongbacks and load-equalizing devices. Naturally, missile range or payload capacity would be reduced, but the overall weapon system would profit.

Figures 1 & 2 show a railway car design which might make railroad launching of large solid propellant missiles more practical. The design uses standard parts and design methods, making it almost immediately available. The car is standard size and gage. Its trucks use conventional running gear, and the machinery underside, except for some quick attach-detach connections, is the same as on ordinary cars of this size.

The missile used in our example is fictitious. Its length is set at 65 ft, with a major diameter of 72 in. Weight is 150,000 lb with the CG 20 ft from the tail. A solid

propellant is assumed primarily because its weight and presumptive fragility make for some representative problems. The vehicle nevertheless could very well represent some future generations of Minuteman and Polaris.

The launching car is made of five basic parts: an erector structure which serves the added function of strongback for *both* the missile and the rail car; a blast deflector which balances out the jet reactions as well as to direct them away from sensitive equipment; a missile isolation system which can attenuate both shock and vibration inputs; the external skin which serves both as a weather shield and as camouflage; and the erection system which is an electrically driven winch sheave system. This design avoids redundant load-carrying structure, makes best use of available space, and uses a very simple and reliable method of missile erection.

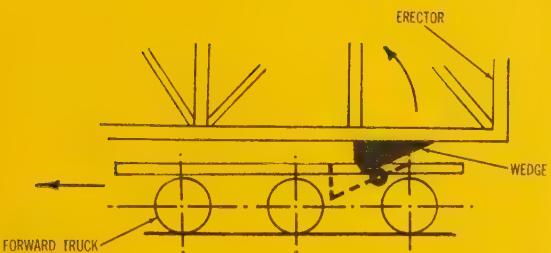
The detail design of a rail launcher will, of course, vary widely depending on its operational range. The car shown here probably will be used only in isolated areas of the U.S. on a restricted area of track and with a travel radius only big enough to avoid one nuclear bomb burst.

On a signal to fire, the train would stop, uncouple the launcher car, move to a safe distance, then erect and launch. It probably isn't practical or necessary to fire from sidings or specially prepared launch sites.

#### External car skin removed

The first step of the launching cycle is to clear away the external car skin. Pneumatic seals are deflated and the inverted U-shape structure threaded off the erector strongback. The skin is transferred either to the tracks or to any adjacent flat car. The trucks are pulled together by the winch system erecting the missile.

Total tension force is about 350,000 lb. With a reaving of 12, the winch is set at 15 tons capacity.



**FIGURE 3:** Mechanical toggle linkage is broken as the nose end of the erector is forced up before the compression strut begins to act. This effect is achieved by increasing the mechanical advantage of the lift mechanism through an added inclined plane and roller system.

The air bag support system is evacuated, freeing the missile and disengaging the umbilicals (Fig. 2). Advantage will be taken of the high launch acceleration of the solid propellant by firing the missile right through the strongback.

If the missile drift conditions don't permit this, the launcher base can be unlatched and the erector structure rotated out of the way. If this method is used, it wouldn't be necessary to remove the external false work from the erector structure.

In this case, however, the erector should be lowered completely and doors closed before missile launch. This measure is designed more to protect the missile from deflected shock waves than to save the shelter structure.

#### Equilibrator decelerates erection

At the start of the missile lift, the mechanical advantage of the erection mechanism can be increased by adding an inclined plane and roller system, forcing up the nose end of the erector, before the compression strut begins to act. This has the effect of breaking the toggle linkage (Fig. 3). An equilibrator also helps the motion. Actually, the main purpose of the equilibrator system is to decelerate the missile at the end of the erection motion.

The shock isolation system uses the missile transport techniques which the Army Quartermaster R&D Command is pioneering. Humping and coupling loads will be avoided, let's hope, but the expensive missile is protected in any event. The low pressure air bags also are very good for vibration attenuation, which makes them especially favorable for railroad service.

Next to the air bag isolation system, the blast deflector will pose the worst design problem. It will be a dry deflector faced with heat- and abrasion-resistant materials. The bucket-shaped deflector is designed to turn the jet 140 deg. Turning through such a large angle

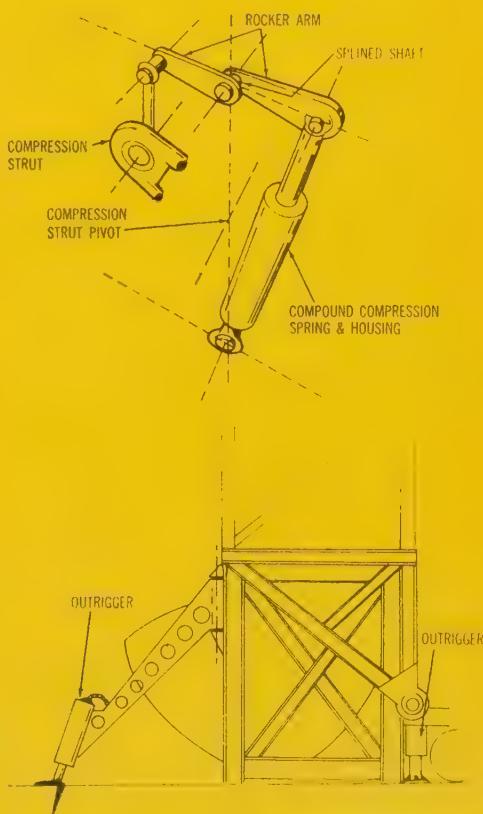
keeps the flame away from the roadbed. Main advantage of the design, however, is that it offsets the vector forces of a conventional 90-deg deflector. These forces would send the launcher car skittering.

An interesting design alternate might eliminate the whole blast effect problem: You could use a Polaris-type air catapult system. Instead of the truss erector, a lightweight aluminum barrel would house the missile. Only 300 psi air would be needed to propel the 50-ton missile 100 ft into the air where it would be ignited safely.

#### Flame deflectors holds launcher

Launch stability is provided by grippers attaching to the rails, and by automatic spades that dig into the road bed (Fig. 4). Neither device really can hold the launcher down, however. The flame deflector does that by diverting the very high downward jet forces and so "anchoring" the launcher base.

This rail car idea isn't the only or even the best technical approach to the problem. Much more detailed work still is needed. However, our concept shows the feasibility of a really inexpensive and lightweight rail launcher design. Production cost of the railway launching car is estimated to be about \$200,000, including all structure and auxiliaries.—End



**FIGURE 4:** Launch stability is provided by grippers that attach to the rails and by automatic spades that dig into the road bed. However, neither of these devices can really hold the launcher down. That job is done by the flame deflector,

## Shock-proofing for hardened bases

- Site conditions can be simulated
- Shock mounting sometimes preferable
- Shock spectra reproducible in the lab

by E. G. Fischer and H. H. Gray,

Advisory Engineer, Research Laboratories, & Manager, Marine Transportation & Aviation Facilities Sales Dept., Westinghouse Electric Corp.\*

**H**ARDENED missile installations cannot be protected from a direct hit with an atomic bomb. They can be designed to withstand—to some extent—the effects of “nearby” atomic explosions.

Naturally, the damage from any given explosion depends upon the type and size of warhead as well as on the ground conditions. In dry soil, for example, a 10-megaton H-bomb would gouge a crater nearly half a mile across and 240 ft deep. Every brick building within seven miles would be leveled. And if you were standing 10 miles from the explosion, you would be dead from radioactive fallout within half an hour.

In solid rock, the ground shock displacements at some distance from the crater might be measured in inches. But shock accelerations would be up around a few hundred g. Conversely, in sandy soil the displacements might be measured in feet and the accelerations might be under 100 g. As a result, the ground shock a reinforced-concrete enclosure must withstand depends upon geographic location as evaluated in terms of seismic exploration. The effects on the enclosure

and on the equipment structures within it, are a function of the enclosures, and the structures' dynamic characteristics express in terms of their respective modes of vibration and natural frequencies.

The major component of the ground shock environment is a transient mechanical motion excited by an overpressure air blast disturbance (*Fig. 2*). In the case of high-yield weapons, the duration of the pressure decay will be much longer than the pressure rise time, so that only the rise time and total impulse have to be specified for design purposes.

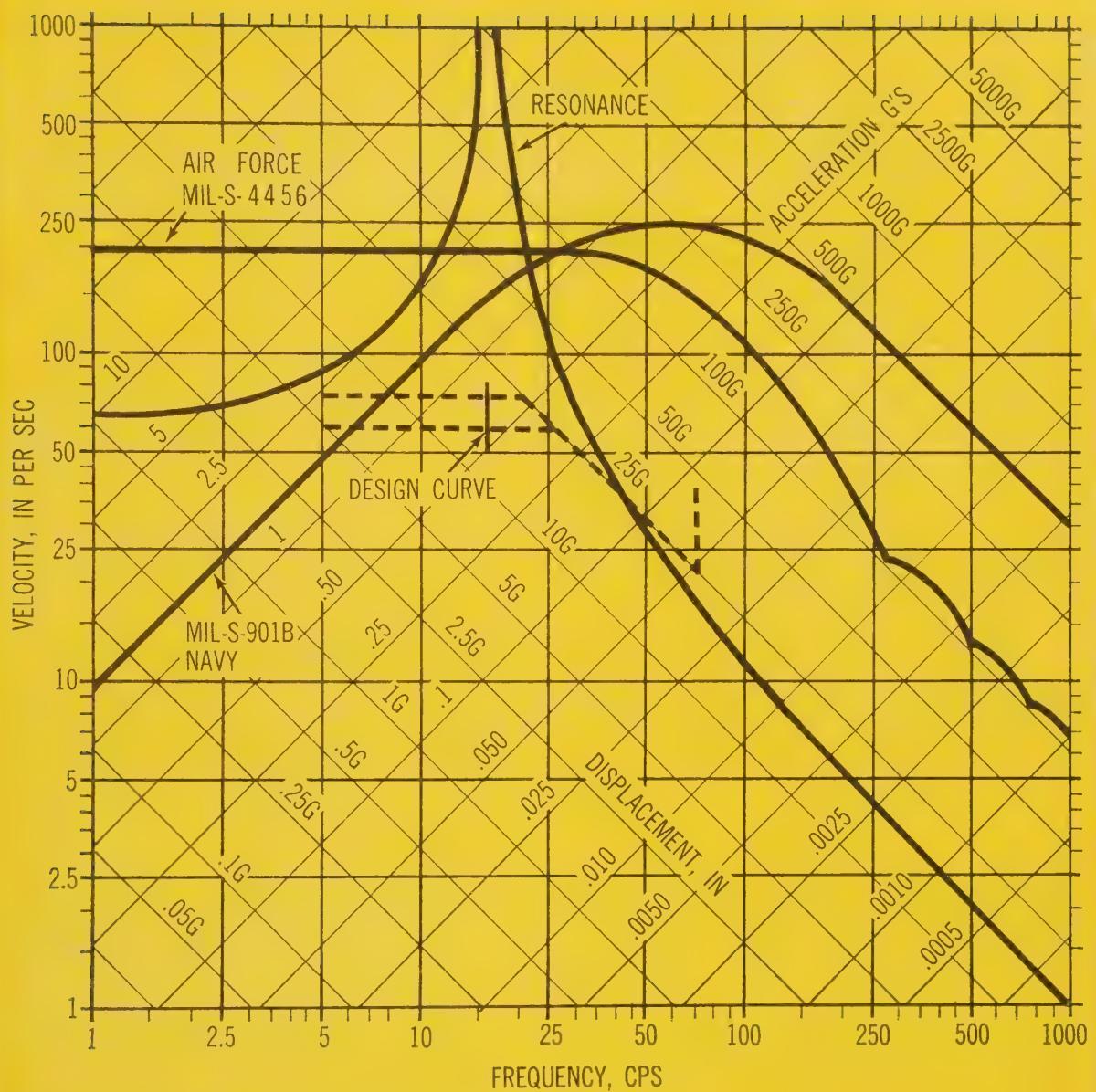
All discussions of hardened missile bases formerly were keyed to some value of the free-air overpressure, such as 1000 psi, at some specified distance from ground zero. This is a convenient reference term that has been used widely, but it is of no immediate use to a designer until the response characteristics of the earth have been interposed. Roughly speaking, the traveling wave of free-air overpressure has a “steam roller” effect—it pushes both down and forward on the ground ahead of it.

### Reed gages give the shock spectrum

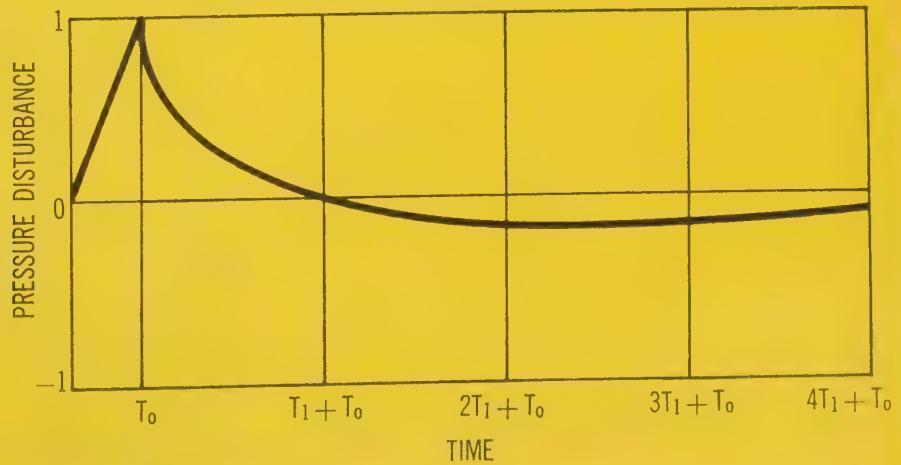
Under field test conditions, a shock spectrum can be derived from the transient-response records of several multi-frequency reed gages buried in the ground at various depths and distances from ground zero. Such shock instruments can be represented schematically as a series of simple spring-mass systems of different natural frequencies. A time record can be obtained of the relative motion under shock between each mass and its moving support. Assuming that a particular reed is a simple model of an equipment structure, then the relative motion can be used directly by the designer to calculate stress value.

\* Research Laboratories, Apparatus Div., Westinghouse Electric Corp., 3 Gateway Center, Pittsburgh 30, Pa.

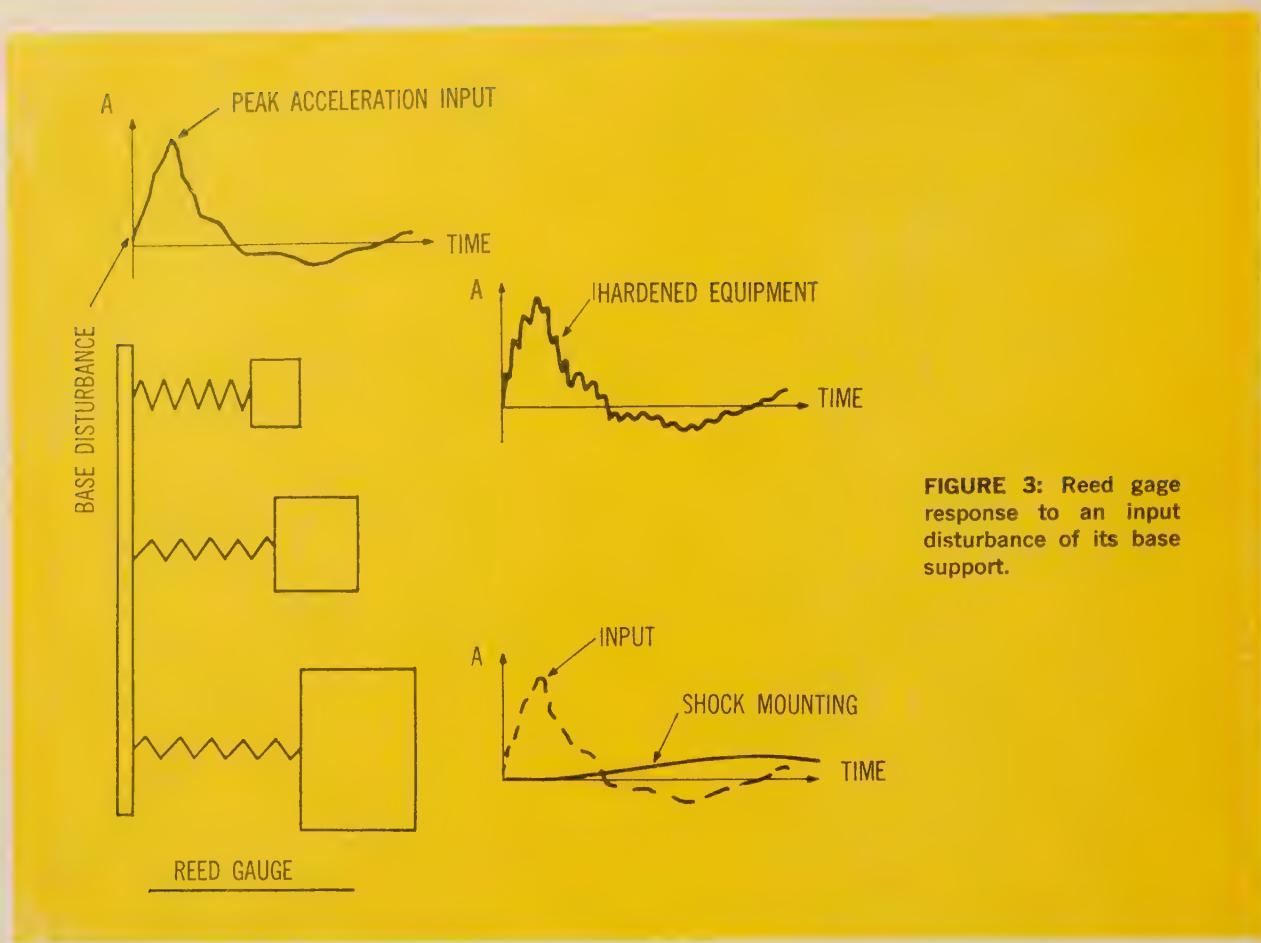
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**FIGURE 1:** Logarithmic chart of general shock spectra.



**FIGURE 2:** Modified overpressure air blast disturbance.



**FIGURE 3:** Reed gage response to an input disturbance of its base support.

*Figure 2* shows possible effects of a random acceleration-deceleration disturbance on the different elements of a reed gage. Note that the smallest element, which represents hardened equipment built to "take it," follows the input disturbance very closely. In this case the peak acceleration would be the design criterion.

The largest element in *Figure 3* marks the other extreme — equipment that is protected merely by shock mounting. Only a small fraction of the peak acceleration gets through. In this case, the peak displacement of the base (not the peak acceleration) is the design criterion for determining how much "rattle-space" must be allowed for low frequency shock mounting.

#### Frequency range from 10 to 200 cps

Most equipment structures fall between the two extremes described. Fundamental natural frequencies range from 10 to 200 cps, and at these values the so-called starting velocity or momentum concept is the usual criterion for design.

*Figure 1* shows a special four-way logarithmic chart giving the peak values of the related displacement, velocity, and acceleration characteristics of transient motion response plotted against natural frequency. Typical shock spectra of Navy and Air Force test specs show the shock levels to which equipments have been successfully designed. When ground spectra for high

yield weapon tests are plotted on this chart and fall below or within the group of curves shown, equipment is available or can be readily adapted to "live" in this shock environment.

In practice, design curves are derived from field test data for given overpressures and geographical locations. The curves—expressed in terms of the motion characteristics (acceleration, velocity, and displacement) for each frequency in the spectrum—can then be used to determine the accelerations and relative motion that the equipment must withstand.

According to the typical design curve (*Fig. 1*), an equipment structure (such as a switch gear cubicle) calculated to have a natural frequency of 50 cps must be designed to withstand peak accelerations of 25 g. (Follow the 50-cps line vertically to the design curve.) The relative deflections of the flexible members will be 0.1 in.

#### Fragile equipment can be mounted

Sometimes it is preferable to shock-mount fragile, "unhardened" equipment. For example, equipment rated at a five-g fragility level will need a five-cps shock mounting. The allowable-motion, or rattle-space, requirement for the mounting would be  $\pm 2$  in. The shock input velocity would be 60 ips.

Shock spectra can be reproduced in the laboratory by dropping the equipment into a bed of sand (or some

other representative shock absorbing media) under controlled impact velocities. Test setups using this technique have been developed, such as the Air Force's Mil-S-4456.

With simple dynamic model, such tests yield good results. However, combinations of equipment require more complete investigation to determine the effects of equipment interaction. All probable reaction modes must be analyzed and examined on a system basis.

Subcomponents can be subjected to destructive resonance frequencies by the shock-excited vibration of the primary structure. Because of this effect, engineers have come up with the so-called "octave rule" for separating the natural frequencies of successive tiers of a cascaded structure—the design is made to progress from a somewhat flexible support for the massive primary components to a more rigid support for the lighter sub-components.

### Shock levels vary within a site

Not all equipment in an underground concrete enclosure needs to be designed for the same high level of shock spectra. For instance, in a dome-shaped enclosure with a floor and separate flexible equipment platforms, the shock attenuation characteristics of the overall system are such that three distinct shock zones can be established (Fig. 4). Peak accelerations, for example, go from 200 to 50 to five g as you pass through the successive zones.

The ultimate design goal for hardened missile installations is to raise the fragility level of equipment (using shock mounting where necessary) so that it comes close to the structure's capability to withstand the ground shock environment. In this way, the best possible overall base design can be achieved.—End

### Ground Shock Damage Criteria for Moderately Deep Underground Structures

Type of Structure	Distance from Surface Zero (crater radii)	Dam- age Class*	Nature of Damage
Relatively small, heavy, blast-resistant (shelters)	1 1/4	A, B	collapse or severe dis- placement
	1 1/4-2 1/2	C	shock damage to interior equipment
	2-2 1/2	D	severance of brittle con- nections, slight crack- ing at structural dis- continuities
Relatively long, flexible (pipe- lines)	1 1/2	A	deformation & rupture
	1 1/2-2	B	slight deformation, some rupture
	2-3	C	failure of connections

\* Blast damage is commonly classified from A through D in order of decreasing severity.

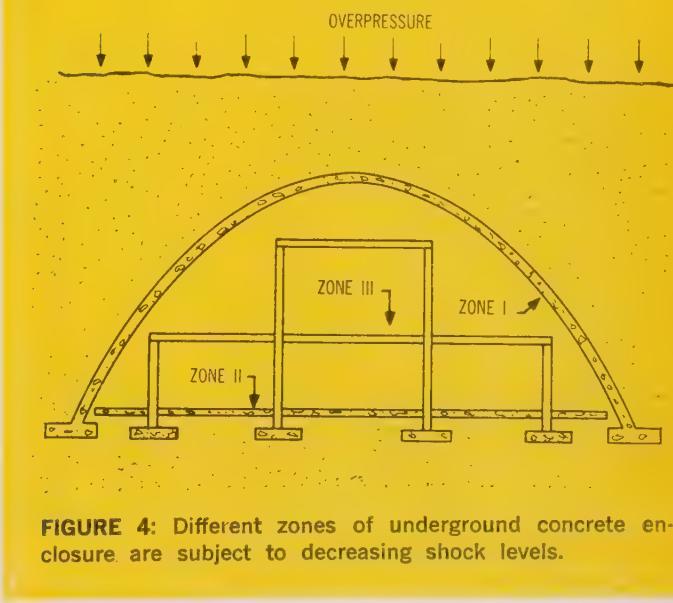
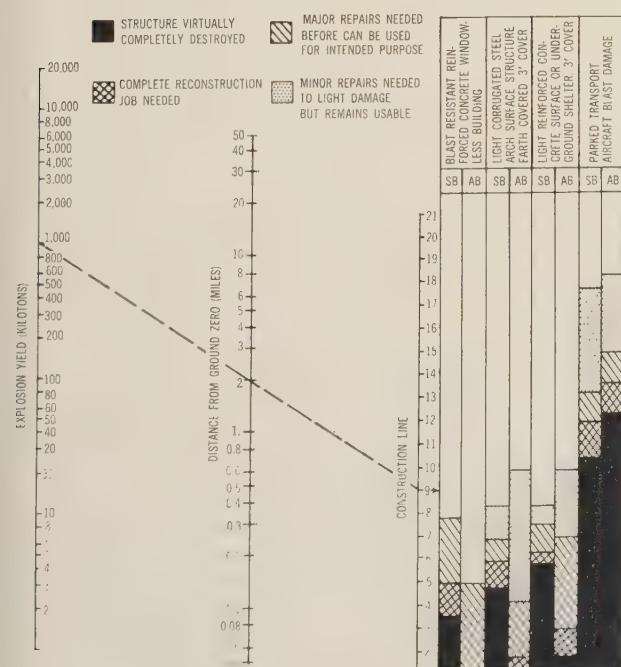


FIGURE 4: Different zones of underground concrete en- closure are subject to decreasing shock levels.



DAMAGE-DISTANCE relationships for diffraction-type struc- tures (AEC data). "SB" and "AB" indicate surface and air bursts.

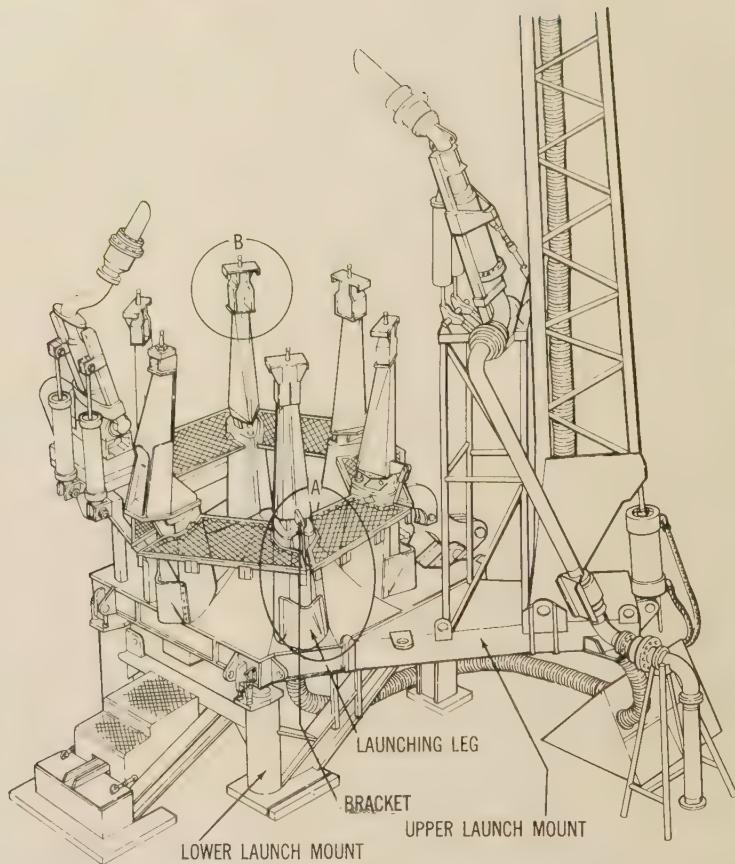
# design progress

by Irwin Stambler

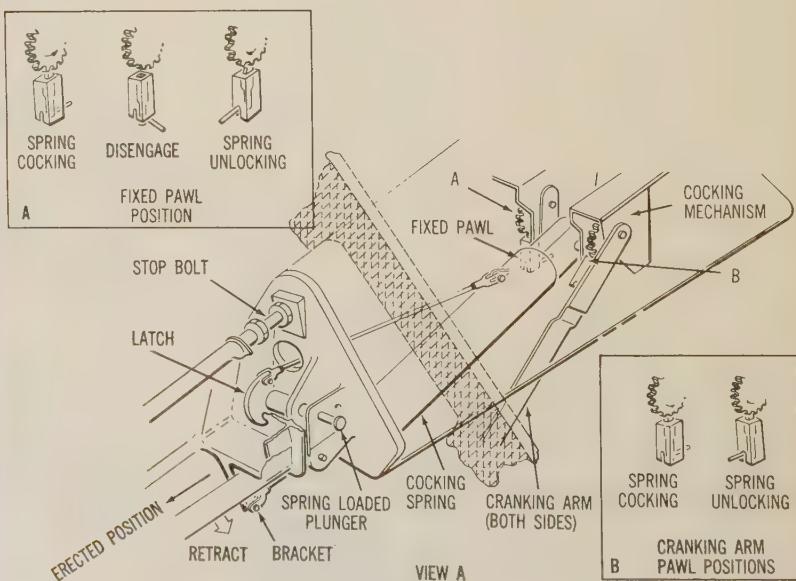
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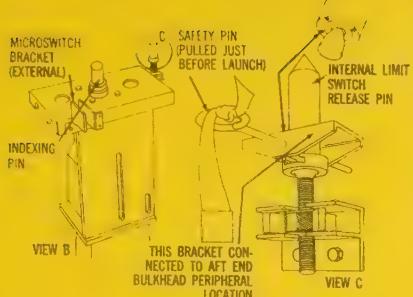
## Launcher-transporter highlights simplicity of Thor GSE

THE THOR'S near-perfect record of 16 successful launches out of 18 attempts during the first half of 1959 testifies to the excellence of the IRBM's GSE. Most of the GSE units are mobile vans. These were chosen partly for mobility but mainly, officers at USAF's Ballistic Missile Div. state, to permit prepackaging of key types of equipment. This approach, they claim, has led to a highly efficient production-line method for obtaining repeatability and reliability. If a unit goes bad on the line, its trailer is pulled out, and another is plugged in. The simple, rugged construction of the entire system is shown by these detail sketches of key parts of the launch mount and the transporter-erector. Extra strength to take ground loads is put into the support device rather than the missile. Food Machinery & Chemical is the Thor associate contractor for the launch mount and semitrailer.

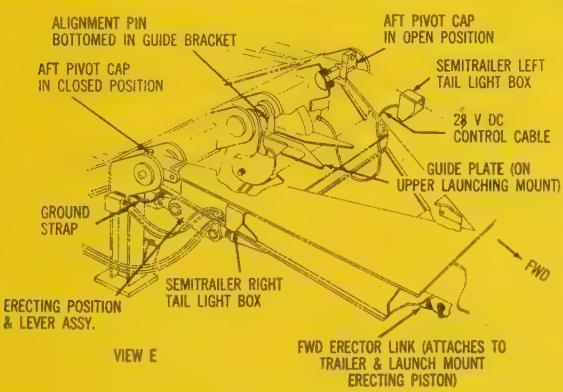
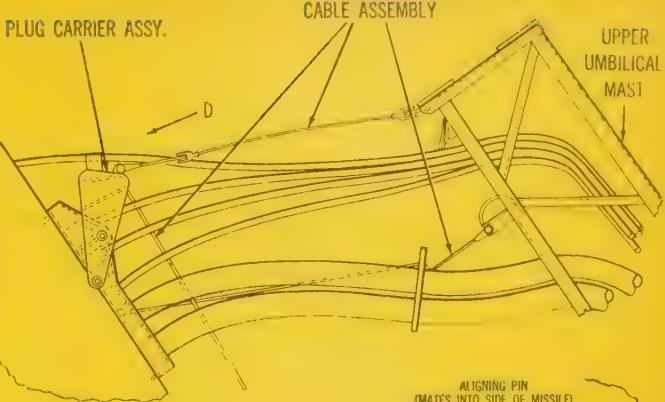


**ERECTING LAUNCHING** mount for Thor in the launch position. The Thor base mates with six indexing pins on the launch legs. Below: Rotated View A—Lower section of the launch leg (typical) in the launch position and unlocked.





**VIEW B.** Detail of upper launch leg section. Microswitch bracket holds limit switch so it bears against aft end of missile. When missile is released, switch actuates kickover mechanism for leg.

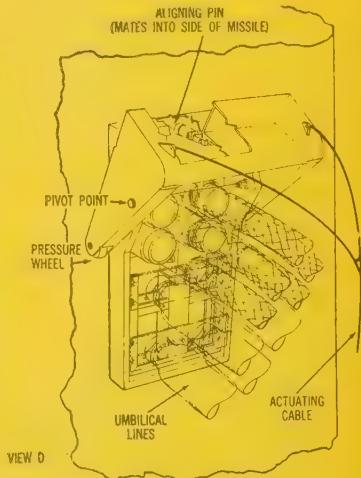


**VIEW E:** Attachment of semi-trailer to erecting-launching mount.

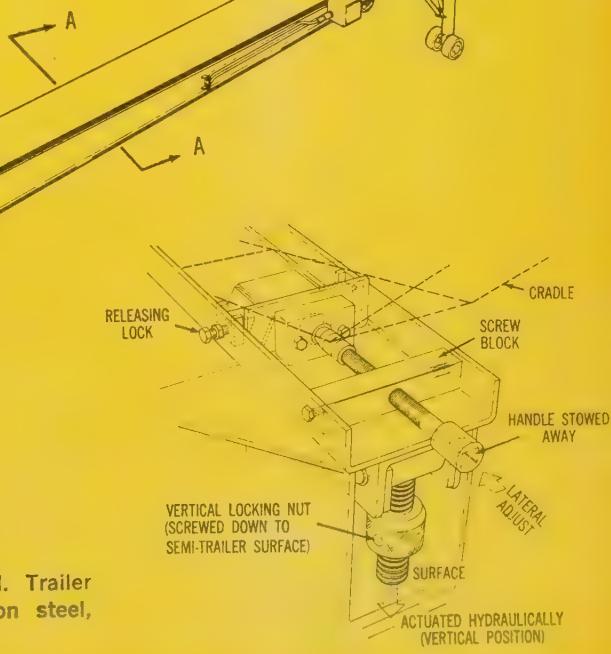
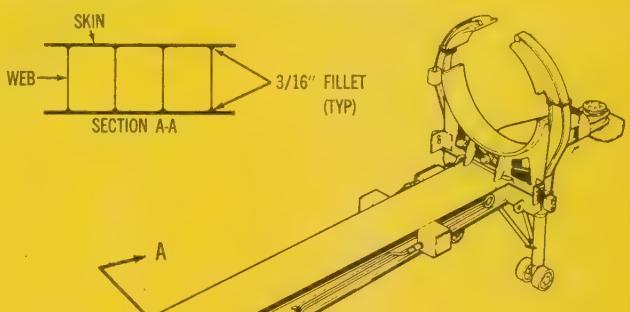


**SEMI-TRAILER** transporter assembly. Unit has steerable aft end. Trailer body is of Commercial ASTM A242 weldable quality low carbon steel, 3/16 in thick. Right: View F—Cradle installation.

**UMBILICAL LINE** plug carrier design is (above and right). When actuating cable is pulled, it causes pressure wheel to push carrier away from missile to disconnect umbilical lines. Since cable is shorter than umbilical lines (between mast and missile), it releases plug carrier before lines can cause towing effect. Left: Lower launch mount assembly and routing of cables and plumbing with missile in erected position.



**SECTION A-A (rotated):** Typical semi-trailer body construction. Skins and webs are welded together by electric-arc-filled method. Four webs are used through most of body, added webs in aft section, where body flares out for connection to launch mount.



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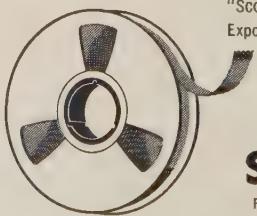
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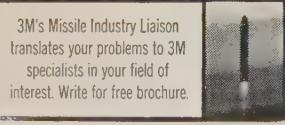


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# Ground support for nuclear aircraft

- Reactor core best handled separately
- Chemical fueling methods can be adapted
- Tenders would service nuclear sea-planes

by Harry L. Loats, Nuclear Engineer,  
Flight Refueling, Inc.\*

**T**HREE are two basic ways of handling and servicing nuclear aircraft on the ground:

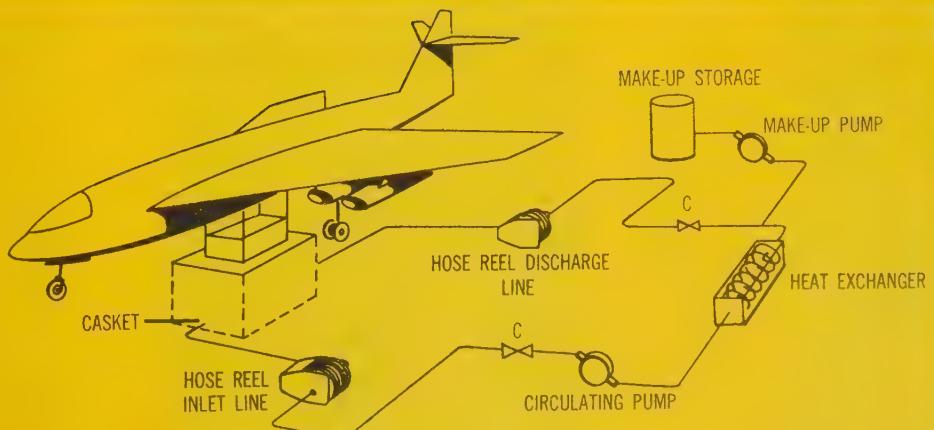
- Provide a remote area for completely automated servicing of both airframe and nuclear powerplant.
- Remove the nuclear powerplant from the airframe, and service the two separately.

Radiation obviously is what makes servicing and handling nuclear aircraft such a problem. It comes not only from the reactor itself but also is induced in other parts of the plane.

Because of the weight factor, complete reactor shielding cannot be provided. Therefore, additional shielding probably will have to be provided during ground servicing and checkout. Such extra shielding is especially likely if no more than "shadow shielding" is used in the plane.

\*Flight Refueling, Inc., P.O. Box 1701, Baltimore 3, Md.  
**more on page 71**

**FIGURE 1:** Ground cooling system for reactor being removed from the plane. The hose reels automatically take up the slack as the casket containing the reactor is moved away to the remote servicing facility.



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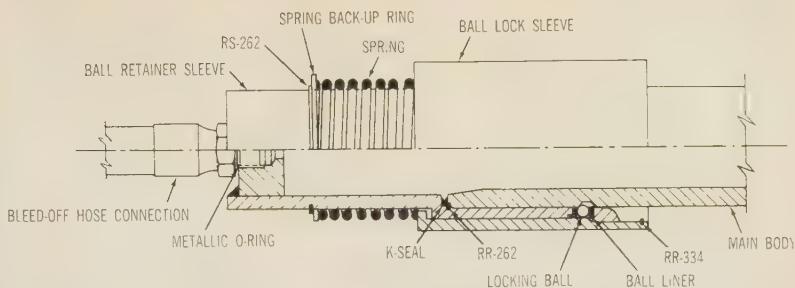
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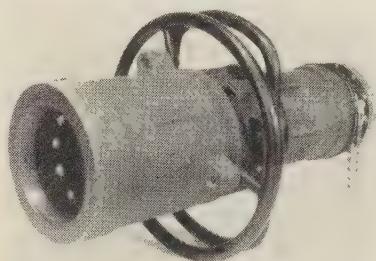
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## **NUCLEAR . . .**



**FIGURE 2:** Hydraulic and pneumatic disconnect handles non-corrosive reactor coolants at pressures up to 3000 psi and temperatures up to 600 deg F. Flexible hose would be used with this disconnect.



**FIGURE 3:** Ground adapter for chemical fuels could be modified for nuclear service.

problems of reactor poisoning by fission fragments after shutdown, when poison is no longer removed by neutron absorption processes. Because of the poisoning, the reactor's available reactivity is decreased, which could cause serious start-up problems—there might be a long delay before the fission fragments are sufficiently decayed.

Let us assume we are dealing with a direct-cycle nuclear turbojet aircraft. Air is ducted from the compressor through the reactor, in which heat is generated by nuclear fission in the fuel elements. The heated air then passes by forced convection into the turbine and from there out into the atmosphere, providing the thrust. Beside nuclear fuel, our aircraft also would have to carry conventional fuel—for takeoff and landing near populated areas and for emergency use in case of a nuclear malfunction.

itself. This technique, which would allow us to produce a nuclear aircraft in a very short time, provides adequate shielding near the crew compartment but only limited shielding in other areas of the plane that are uninhabited and more radiation-resistant. The additional ground shielding may use either liquid or solid materials.

#### **Heat is still produced after shutdown**

Two peculiar problems of nuclear aircraft are afterheat and gamma activity in the core and other parts. After the reactor is shut down and neutron production ceases, heat is still produced by the interaction of gamma rays and reactor materials. Therefore the reactor must be cooled at all times, with the cooling requirement highest just after shutdown. The biological effect of the decay gammas also must be considered.

Of the two basic handling methods we have outlined, we shall consider here only the second, in which the reactor core is separated from the airframe. This technique seems better suited to solving the

#### **Remote nuclear fueling fully feasible**

Remote chemical fueling of course has been studied for many years. As a result, the remote ground refueling of nuclear turbojets poses no problems. For instance, a mod of a Flight Refueling ground adapter could be used (Fig. 3). This push-pull ball detent lock device includes automatic self-sealing.

Operational and system checkout will be done by methods similar to those now used on missiles. The checkout system would use self-sealing as well as non-self-sealing electric, hydraulic, and pneumatic disconnects that are joined automatically (Fig. 4). Offset of the

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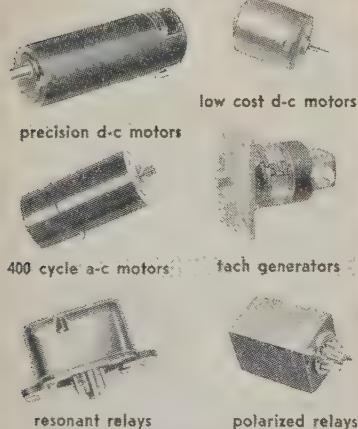
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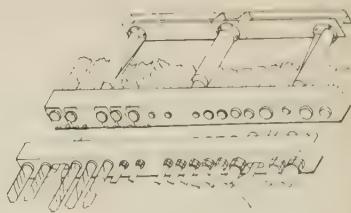


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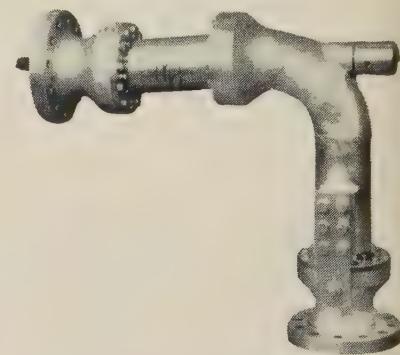
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**FIGURE 4:** Disconnect plug brings in hydraulic, electric, and pneumatic connections for servicing of the reactor while it is being removed from the plane.



**FIGURE 5:** Flexible reactor coolant coupling for airborne and ground service.

two valves would be allowed for in the juncture design.

Automatic disconnects also must be provided for the reactor parts — specifically for the primary and auxiliary coolant flow circuits, the instrumentation and control circuits, and the control drive circuit.

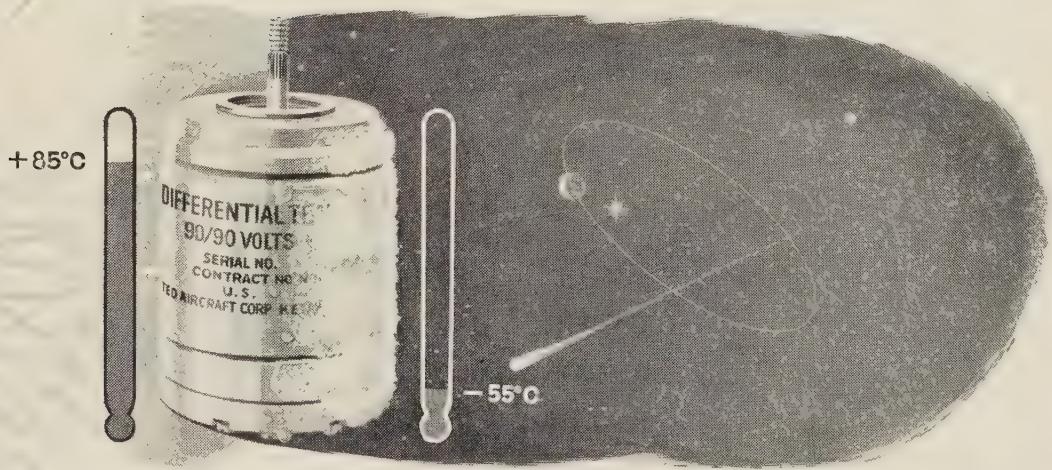
*Figure 6* shows two self-sealing disconnects designed to handle various liquids and gases used as reactor coolants as well as standard fuels. The master seal makes or separates before locking or unlocking.

The disconnect for the control rod actuator mechanisms will be subject to extreme rigors of temperatures, pressures and radiation, since it will be near the operating reactor core. *Figure 2* shows such a disconnect—a sleeve-operated, half-detent lock device using a pressure-actuated metallic sealing member. It would be suitable not only for the gas-cooled reactor we are considering here but also for other reactors.

When the reactor core is separated from the airframe, the control elements must remain with the

**more on page 75**

# CAN A SYNCHRO MAINTAIN ACCURACY



## OVER A WIDE RANGE OF TEMPERATURE?

Synchros have to take punishment. They are often exposed to blistering heat and stratospheric cold . . . and they still must operate accurately.

Naturally, Ketay synchros meet *and surpass* the new MIL-S-20708A ambient temperature requirement of  $-55^{\circ}$  C. to  $85^{\circ}$  C. (or to  $75^{\circ}$  C. for size 23). Even more important, they give you a remarkable 6 minute accuracy *over this whole temperature range*.

Ketay is the *only source* currently manufacturing and shipping a complete line of the new Mil-type synchros. They are available in production quantities in sizes from 8 to 23, with 60 cps units as small as size 15. Because of their superior accuracy, with some units offering 3' accuracy at room temperature, Ketay synchros one or more sizes smaller than previously required may often be used.

Ketay engineers are working on many advanced environmental and accuracy problems in developing prototype systems, and have an unusual degree of experience in high temperature work. Why not call or write for help in solving your special problems?

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Division of United Aircraft Corporation

KETAY DEPARTMENT, Commack, Long Island, N.Y.

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THE MODERN TOOL...AT WORK FOR MODERN INDUSTRY



# NOW! 4 NEW POLYKEN THERMO-ELECTRICAL TAPES

New! Polyken #292 glass fabric tape with silicone adhesive for use in high-temperature applications such as jet aircraft.

Four new tapes—three thermo-setting, one thermo-plastic—have been added to the Polyken line.

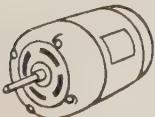
That means you can now get a Polyken tape for almost any electrical use you can think of. No more need to search among several manufacturers.

Nice to know, too, that now all Polyken tapes can be assorted for quantity discounts.

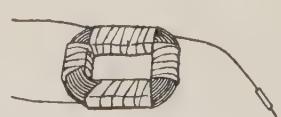
Polyken . . . the brand with half a century of scientific research and proved

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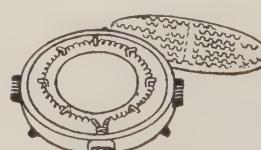
Polyken representatives are among the industry's best trained technicians in the use and application of industrial tapes. They are ready to help you. Check with the Polyken Industrial Tape Distributor nearest you. Look in the phone book under "Tapes", or write to Polyken Sales Division, 309 W. Jackson Blvd., Chicago 6, Illinois. (In Canada, write Polyken, Curity Ave., Toronto.)



New! Polyken #158 cotton-backed electrical thermo-setting tape. Used in electric motor construction, etc.



New! Polyken #154 acetate cloth-backed thermo-setting tape, used for small gauge coil winding, etc.



New! Polyken #293 glass cloth-backed electrical thermo-setting tape is used for electrical appliances, etc.



# Polyken®

INDUSTRIAL TAPES

THE KENDALL COMPANY

Polyken Sales Division

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• PROTECTIVE COATINGS

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## POLYKEN DISTRIBUTORS

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Pine Bluff..... Smith Paper Products Co.

### CALIFORNIA

Emeryville..... Zellerbach Paper Co.  
Fresno..... Zellerbach Paper Co.  
Hawthorne..... American Latex Products Co.  
Highland..... Richmond Paper Co.  
Hollywood..... Reese Supply Co., Inc.  
Los Angeles..... Fillmore & Garber  
Los Angeles..... L A Supply Co.  
Los Angeles..... Kent H. Landsberg Co., Inc.  
Los Angeles..... Noland Paper Co., Inc.  
Los Angeles..... Western Fibrous Glass Products  
Los Angeles..... Wilson Paper Co.  
Los Angeles..... Zellerbach Paper Co.  
National City..... Zellerbach Paper Co.  
Oakland..... Harry P. Roberts Co.  
Sacramento..... Zellerbach Paper Co.  
San Diego..... Buell-Town Co.  
San Francisco..... Gilmore Steel & Supply Co.  
San Francisco..... C. J. Hendry Co.  
San Francisco..... Hobart Bros.  
San Francisco..... Western Fibrous Glass Products  
San Francisco..... Zellerbach Paper Co.

### COLORADO

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Denver..... Katzke Bros. Paper Co.  
Denver..... Union Supply Co., Inc.

### CONNECTICUT

Bridgeport..... Equity Paper Co.  
Bridgeport..... Loft-Merlin, Inc.  
Bridgeport..... Rourke-Eno Paper Co.  
Hartford..... Rourke-Eno Paper Co.  
New Britain..... Mill Supplies, Inc.  
New Haven..... The Chatfield Paper Co.  
Stamford..... Loft-Merlin, Inc.

### FLORIDA

Jacksonville..... Industrial Marine Service  
Jacksonville..... Sperry Packaging & Distributing  
Miami..... Gondas Corporation  
Tampa..... Industrial Supply Corp.

### GEORGIA

Atlanta..... Dillard Paper Co.  
Atlanta..... Wyant & Sons Paper Co.  
National Paper Div..... Dillard Paper Co.  
Macon..... Dillard Paper Co.

### ILLINOIS

Chicago..... Abana Products Inc.  
Chicago..... Chicago Paper Co.  
Chicago..... Chukerman Paper Co.  
Chicago..... Durable Products  
Inlander-Steindler Paper Co.  
Chicago..... Knox & Schneider  
Chicago..... Schwarz Paper Co.  
Peoria..... Schwarz Paper Co.

### INDIANA

Ft. Wayne..... Allen Steel & Supply Co.  
Hammond..... Inlander-Steindler Paper Co.  
Indianapolis..... Dom-Harris Inc.  
Indianapolis..... Duo-Fast of Indiana  
Ochs Paper Co., Inc.  
South Bend 24..... Valley Paper Co., Div. of  
Schwarz Paper Co.

### IOWA

Davenport..... Peterson Paper Co.  
Sioux City..... Carpenter Paper Co.  
Waterloo..... Waterloo Paper Co.

### KANSAS

Wichita..... Southwest Paper Co.

### KENTUCKY

Louisville..... Southeastern Paper Co.

### LOUISIANA

New Orleans..... Stevens-Band Paper Co.

Shreveport..... Louisiana Paper Co., Ltd.

### MARYLAND

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Hyattsville..... Seaboard Papers, Inc.

### MASSACHUSETTS

Boston..... Andrews Paper Co.  
Cambridge..... H. J. Dowd Co., Inc.  
Springfield..... Carter Paper Co.  
Springfield..... Rourke-Eno Paper Co., Inc.  
Worcester..... The J. C. Campbell Paper Co.,  
of Worcester

### MICHIGAN

Battle Creek..... Cortright Paper Co.  
Detroit..... F. W. Winne & Son Inc.  
Grand Rapids..... Grand Rapids Paper Co.  
Jackson..... Crown Paper & Bag Co.  
Lansing..... Goethy Company  
Muskegon..... Steindler Paper Co.

### MINNESOTA

Minneapolis..... Martin F. Falk Paper Co.  
Duluth..... Martin F. Falk Paper Co.

### MISSOURI

Joplin..... Joplin Paper Co.  
Kansas City..... Bossert Company  
Wertgate Paper Co.  
Kirkwood..... Industrial Ideas  
St. Louis..... Royal Papers, Inc.  
St. Louis..... Rubber Products Corp.

### MONTANA

Billings..... Winter Hardware Co.

**NEBRASKA**  
Omaha..... Nogg Bros. Paper Co.

### NEW JERSEY

Clifton..... Ralph E. Baker Co.  
Elizabeth..... Hand Hardware  
Englewood..... Coronet Paper Corp.  
Hoboken..... D. S. MacCorkle, Inc.  
Newark..... Abco Plastic & Supply Co.  
Newark..... Herbert A. Post, Inc.  
Paterson..... Theodore R. Levine & Sons  
Ridgefield..... George H. Swatek  
Trenton..... Pack & Seal, Inc.

### NEW MEXICO

Albuquerque..... Equipment Sales & Mfg. Co.

### NEW YORK

Astoria, L. I. .... Herbert A. Post, Inc.  
Buffalo..... Hartfield-Healy Supply Co.  
Buffalo..... Presque Isle Paper Products  
Buffalo..... Union Paper & Twine Co.  
Cohoes..... Shooker Paper Co.  
Garden City, L. I. .... Hogan Industrial Supply Co.  
Elmira..... Wright Supply Co.  
Elmira Heights..... The Welles Supply Co.  
Jamaica..... Viking-Criterion Paper Corp.  
Long Island City..... Coy Disbrow, Div. of Pohman Co., Inc.  
New York..... Geo. W. Miller & Co., Inc.  
New York..... Robert Spector Co.  
New York..... Westwood Paper Co., Inc.  
Rochester..... The Mill Andrews Paper Co.  
Syracuse..... Allied Products  
Tray..... Sperry Supply Corp.  
Utica..... Smyth-Despard Co.

### NORTH CAROLINA

Charlotte..... Dillard Paper Co.  
Greensboro..... Dillard Paper Co.  
Raleigh..... Dillard Paper Co.

### OHIO

Cincinnati..... The Chatfield Paper Corp.  
Cleveland..... The Central Ohio Paper Co.  
Cleveland..... Gascon Paper Co.  
Cleveland..... Union Paper & Twine Co.  
Columbus..... The Cincinnati Cordage & Paper Co.  
Dayton..... Reliable Rubber Products Co.  
Hubbard..... Federal Wholesale Co.  
Toledo..... The Ohio & Michigan Paper Co.  
Youngstown..... The Hearn Paper Co.

### OKLAHOMA

Oklahoma City..... C. B. Anderson Co.  
Oklahoma City..... Service Supply, Inc.  
Tulsa..... C. B. Anderson Electric Co.  
Tulsa..... Industrial Equipment Co.  
Tulsa..... Tulsa Paper Co.

### OREGON

Portland..... Western Fibrous Glass Products  
Portland..... General Rubber & Supply Co.

### PENNSYLVANIA

Hershey..... Hershey Paper Co.  
Johnstown..... Morris Paper Co.  
Lancaster..... United Twine & Paper Co.  
Philadelphia..... The J. L. N. Smyth Co.  
Philadelphia..... Frank W. Winne & Son, Inc.  
Pittsburgh..... The Chatfield & Woods Co.  
Pittsburgh..... Interstate Cordage & Paper Co.  
Pittsburgh..... Morris Paper Co.  
Scranton..... Stan-Tone  
Springfield..... The Boed Co.

### RHODE ISLAND

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### SOUTH CAROLINA

Greenville..... Dillard Paper Co.

### TENNESSEE

Knoxville..... Dillard Paper Co.  
Knoxville..... The Cincinnati Cordage & Paper Co.  
Memphis..... Moyer Myers Paper Co.  
Nashville..... Clements Paper Co.

### TEXAS

Dallas..... Airco Rubber Prod. of Dallas, Inc.  
El Paso..... Field Parker Co.  
Grand Prairie..... C. P. Waggoner Sales Co., Inc.  
Houston..... Frank W. Winne & Son, Inc.

### UTAH

Salt Lake City..... American Paper & Supply Co.  
Salt Lake City..... Equipment Supply Co.  
Salt Lake City..... Great Western Supply Co.  
Salt Lake City..... J. B. Tile Co.

### VIRGINIA

Bristol..... Dillard Paper Co.  
Norfolk..... Empire Machinery & Supply Co.  
Norfolk..... J. Henry Holland Corp.  
Richmond..... Industrial Supply Corp.  
Roanoke..... Dillard Paper Co.

### WASHINGTON

Seattle..... Marinc Supply Inc.  
Seattle..... Western Fibrous Glass Products  
Spokane..... Zellerbach Paper Co.

### WISCONSIN

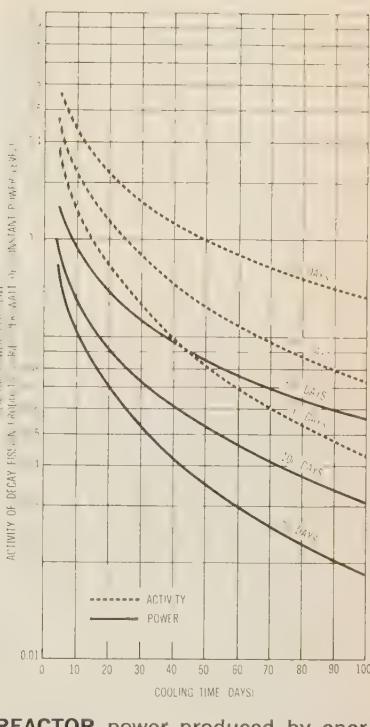
Appleton..... Universal Paper Co.  
Madison..... Schwarz Paper Co.  
Milwaukee..... F. D. Haker Co.  
Milwaukee..... Redi-Products Company  
Milwaukee..... Reliable Paper Co., Inc.  
Neenah..... Sawyer Paper Co.

### HAWAII

Honolulu..... Chapson Bros. Ltd.

Honolulu..... The Thom Co., Inc.

## NUCLEAR . . .



**REACTOR** power produced by energy release from decaying fission products and activity of these products for various cooling periods after shutdown following operating periods of varying lengths.

nuclear core. The reactor mechanisms, therefore, must be designed with remote disconnect features that separate the control element segments and provide positive locking within the core.

Thermal and vibration requirements are also important. To meet them, Flight Refueling has developed several concepts for relatively compact, lightweight flexible joint devices. Figure 5, for instance, shows a unit in which the separation forces are taken by the solid flexible member through the center of action, while vibration and expansion take place through ball-and-socket-type joints with a very wide range of action.

Either internally in the airframe or externally equipment must be provided for the lowering of the primary reactor package (core and pressure vessel) into an auxiliary shielded cooling system. The arrangement shown in Figure 1 includes a solid shielding canister, which probably would be made of lead and use structural steel sup-

more on next page

**Polyken**  
INDUSTRIAL TAPES

ports. The canister would be raised into the airframe and enclose the reactor core.

Before removal of the core, auxiliary cooling from the internal aircraft system would have ended. Afterheat cooling therefore would have to be provided by the external system—a closed-loop, forced-convection design using water or air. It would have to operate remotely and automatically from the time the core is removed

until it is ready for re-insertion, transmittal, or burial. Naturally it would be adequately shielded and have fail-safe controls. Extendable, flexible, radiation-resistant hose and response-type reel units would be used.

The procedures worked out so far for nuclear ground handling could easily be adapted to the needs of seaplanes. Existing merchant vessels—possibly equivalent to 300-ft tankers—could be re-

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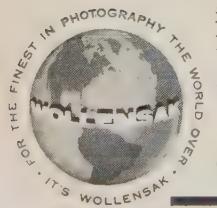
Wollensak Mirrotel Lenses (20", 40" and 80") extend the capabilities of high speed motion picture photography in tracking missiles and in radar boresight applications. They deliver images of excellent resolution and contrast.

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**CAMERAS** • Mirrotel lenses are extensively used with a wide variety of cameras, such as FASTAX, FASTAIR, Flight Research IV-C, Automax, Mitchell (16mm, 35mm), Cameraflex, Eyemo and TV cameras.

**SPECIAL FEATURES** • Mirrotel Lenses can be supplied with reticle printers, fiducial markers, continuous focusing, counters, reflex finders, radiation shields, custom mounting bases for lens and camera (illustrated), neutral density and color filters.

If you need extra long focus lenses of unusual characteristics, **WRITE** Dept. FXL for Mirrotel catalog M-1 and prices. Inquiries invited.

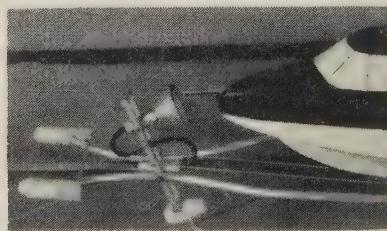


**WOLLENSAK**  
OPTICAL COMPANY • ROCHESTER 21, N.Y.

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**FIGURE 6:** Reactor coolant system disconnects. The unit at bottom can be used with corrosive liquid-metal coolants.



**CRADLE** for remote fueling of a nuclear seaplane from a submarine or a surface ship.

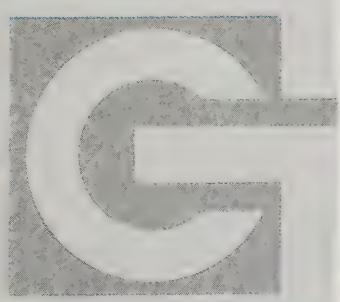
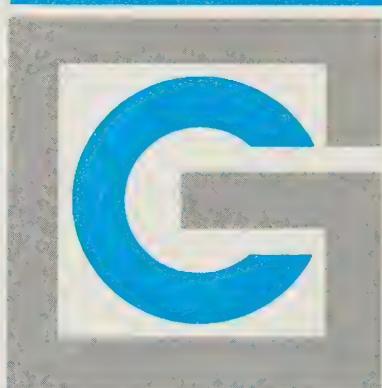
fitted as nuclear support tenders. They would:

- fuel and defuel nuclear seaplanes, handling both reactor materials and conventional fuels;
- store spent fuel elements and cores and provide afterheat cooling for them;
- store unused fuel elements for refueling purposes;
- encapsulate spent fuel elements for transshipment to a remote reprocessing facility;
- provide means for transferring "hot" nuclear materials from the seaplane;
- transfer and store irradiated reactor parts;
- reclaim irradiated aircraft parts.

The tenders also would be able to do modified spent-fuel processing as well as the bulk condensation of liquids and solid waste materials and to package residues from these wastes in case of fuel element rupture.—End

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## Current GSE

### systems and subsystems

*This listing is based on a survey of all weapon system prime contractors, who were requested to list the important use GSE systems and subsystems involved in the projects for which they are responsible. The prime contractors are listed at the beginning of each item.*

**A2F:** Grumman Aircraft Engineering Corp., Bethpage, N.Y.

- Integrated attack-navigation system AN/USA-11 automatic checkout equipment manufactured by Autonetics Div., North American Aviation, Downey, Calif. Used to check operation for go-no-go and localizes any malfunction unit; pinpoints malfunctions to replaceable unit. Automatic checkout equipment adapters manufactured by Airborne Equipment Mfg. (Prime).

**A3J VIGILANTE:** North American Aviation, Inc., Columbus Division, Columbus, Ohio.

- Automatic checkout equipment (Ace) manufactured by NAA (and subcontractors on components) to check out complete operation of bombing-navigation system, including basic navigator, computer, master flight ref. system, radar systems, etc.

**ATLAS:** Convair (Astronautics) Division, General Dynamics Corp., San Diego, Calif.

- Handling and erection equipment manufactured by Goodyear Aircraft Corp., Akron 15, Ohio and Westinghouse Electric Corp., Pittsburgh 30, Pa. to handle, transport, service and erect missile.

- System checkout manufactured by Radio Corporation of America, New York 20, N.Y. to determine operational readiness of equipment and provide data for maintenance and repair.

- Launch controller manufactured by Radio Corporation of America, New York 20, N.Y., coordinate and sequence GSE and missile functions from remote control point.

- Component test system manufactured by Consolidated Electrodynamic Corp., Pasadena 15, Calif. to locate removable parts or subassemblies causing a component to malfunction.

- Launching mechanisms and subsystems manufactured by Consolidated Western Steel Corp. for missile launching.

- Propellant loading system manufactured by A. D. Little Co. for automatic loading fuel, liquid oxygen, and high-pressure helium aboard the missile; holds missile for one hour with environmental protection.

- Pneumatic checkout system manufactured by Minneapolis Honeywell Regulator Co., Minneapolis 8, Minn. for complete missile checkout and maintenance.

**B-58 HUSTLER:** Convair, Fort Worth, Texas

- AN/ARC-57 UHF Communications and AN/ARC-74 Emergency UHF Communications flight line and A&E shop test equipment. Manufactured by Magnavox Co., Fort Wayne, Indiana to check power, receiver sensitivity, and audio response frequency accuracy. Permits complete malfunction isolation to tube, resistor, etc. in A&E shop.

- Defensive electronic countermeasures (DECM) system flight line and A&E shop test equipment. Manufactured by Sylvania Elec. Products, Inc. Buffalo, N.Y. for rapid and conclusive evaluation of the operational capability of the DECM system. Isolates a malfunction to a replaceable module.

- Automatic flight control system flight line and A&E shop test equipment. Manufactured by Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N.J. to evaluate complete system installation, and functionally test (as components) the power control linkage, amplifier computer, etc.

- Airplane recording system flight line and A&E shop test equipment. Manufactured by Melpar, Inc., Falls Church, Va. to check operation in aircraft. Isolates malfunction to tube, transistor, resistor, etc. in A&E shop.

- AN/APX-47 (AG-IFF) and AN/APX-48 (AA-IFF) Flight line and A&E shop test equipment. Manufactured by Motorola, Inc., Phoenix, Arizona to automatically evaluate subsystems installed in aircraft. Complete malfunction isolation in A&E shop.

- Hydraulic component test stand manufactured by Utility Metal Products, Pasadena, Calif., to evaluate individual hydraulic components prior to installation on the aircraft (for forward maintenance shops).

- Active defense system Flight line and A&E shop test equipment. Manufactured by Emerson Elec. Mfg. Co., St. Louis Mo. to evaluate performance of installed subsystem. Isolates malfunctions through dynamic test of radar, ballistic computer, stable platform and tracking control functions.

- Hydraulic pumping unit manufactured by Convair for ground testing, purging and filling the hydraulic system with Oronite fluid.

- Engine gas turbine compressor manufactured by Airessearch, Phoenix, Ariz. for ground starting.

- Ground air conditioning cart manufactured by American Electronics, El Monte, Calif. for ground environment control.

- "Pneudraulic" component test stand manufactured by Sprague Engineering Corp., Gardena, Calif. to functionally evaluate individual components prior to installation on the aircraft.

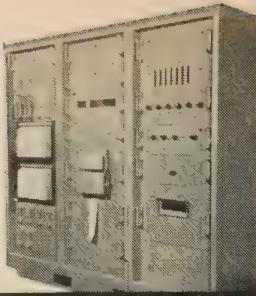
- General aircraft handling equipment manufactured by Convair (some items subcontracted to other vendors) for maintenance and service.

**B-70 VALKYRIE:** North American Aviation, Inc., International Airport, Los Angeles 45, Calif.

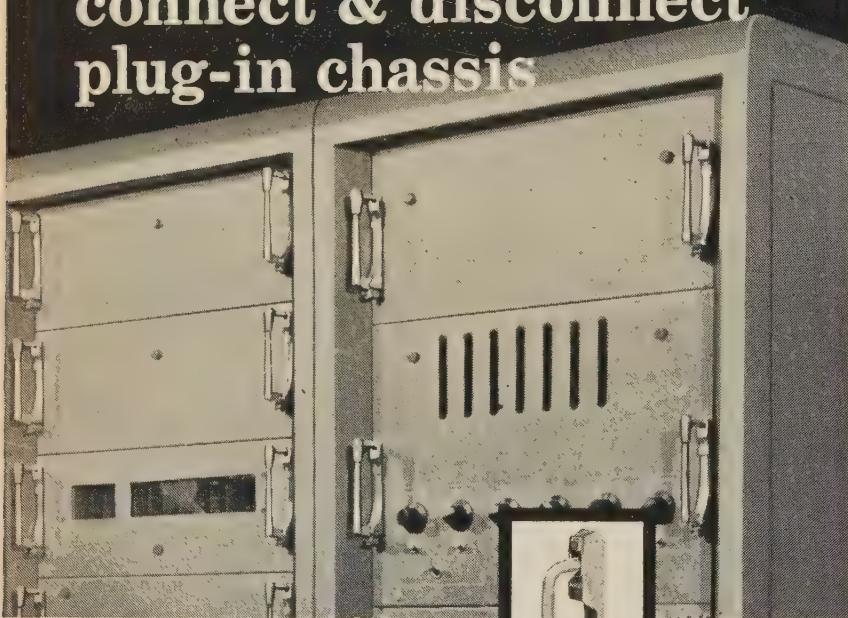
- Alert pod manufactured by Beech Aircraft Co., Wichita, Kan. contains several ground support systems, including one for instantaneous engine starting and others for maintaining all electronic equipment in "warm-up" condition (pod can be carried with B-70 from airfield to airfield).

more on page 80

**DATICO** "digital automatic tape intelligence check out" is made by the Nortronics Div. of Northrop Corporation for the U.S. Air Force and U.S. Army Rocket & Guided Missile Agency. This money and man saving tool provides rapid weapon system evaluation. Note Camloc Chassis Latches.



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**BOMARC:** Boeing Airplane Co., Seattle, Wash.

- Functional checkout equipment (FCO) manufactured by ITT Federal Div., Fort Wayne, Ind. to automatically check out major systems.
- Electrical launching equipment manufactured by ITT Federal Div., Clifton, N.J. to automatically prepare the Bomarc for launch.
- Launcher erector and hydraulic skid manufactured by Food Machinery & Chemical Corp., San Jose, Calif. to erect the Bomarc into firing position.
- Pre-launch command system manufactured by Westinghouse Electric, Electronics Div., Baltimore, Md., to prepare the missile electronically for firing.

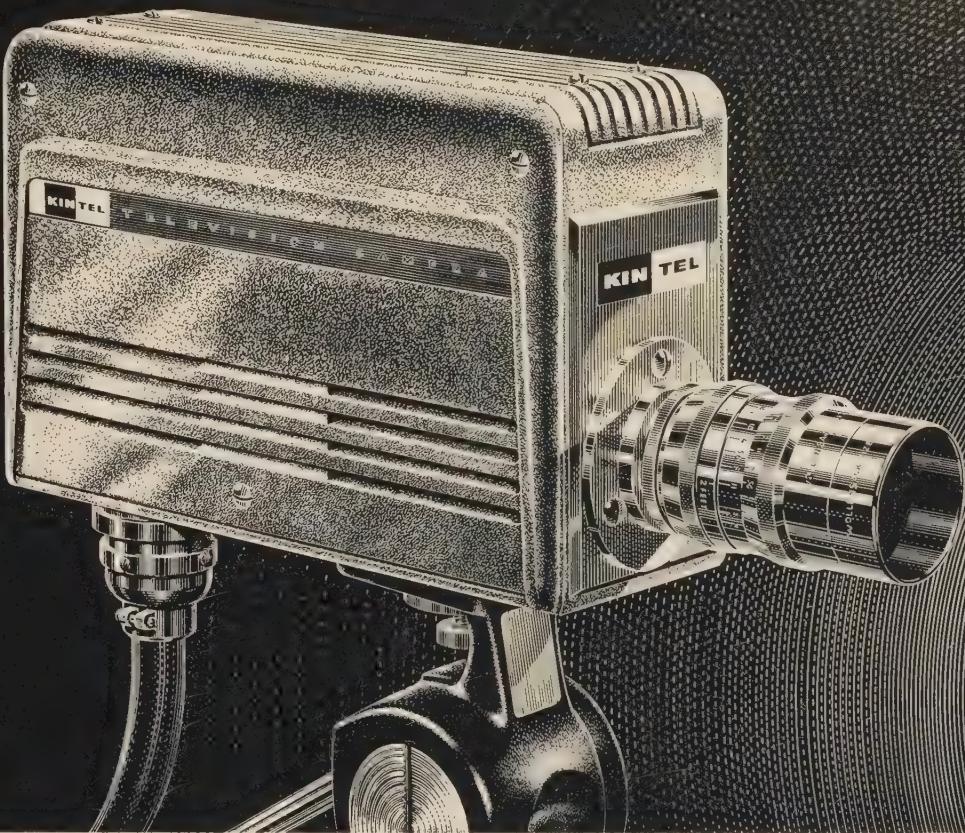
**C-130:** Lockheed Aircraft Corp., Georgia Division, Marietta, Ga.

- Mobile engine test stand manufactured by Jonco Aircraft Corp., Shawnee, Okla. to functionally test a complete C-130 powerplant.
- Engine build-up and transportation truck manufactured by Lockheed for a buildup of a complete power plant and for ground and air transportation.
- RC-130 (APCS) high precision short range navigation system (Hiran) flight simulator manufactured by Waldorf Instrument Co., Long Island, N.Y. for dynamic checks.
- RC-130 (APCS) video system television viewfinder test set manufactured by Thompson-Ramo-Wooldridge, Inc., Dage Television Div., Michigan City, Ind. for a "go-no-go" check of the camera, test pattern projector, and each of their replaceable modules.
- RC-130 (APCS) precision automatic photographic intervalometer system (PAPI), photogrammetric scanner and intervalometer bench test set manufactured by Chicago Aerial Industries, Inc., Melrose Park, Ill. for a complete check of the intervalometer system.
- RC-130A (APCS) camera amplifier mount test set manufactured by Aeroflex Corporation, Long Island, N.Y. to check the amplifier mounts for proper response to input signals.
- RC-130A PAPI image velocity simulator test set manufactured by Chicago Aerial Industries Inc., Melrose Park, Ill. to check the phasing and focusing of the scanner optical system.

**CORVUS:** Temco Aircraft Corp., P.O. Box 69, Dallas 22, Texas.

- Operational test and checkout equipment manufactured by Temco to check readiness of assembled missiles and launching aircraft aboard ship; check readiness of missile sections prior to loading aboard ship.
- Maintenance checkout equipment manufactured by Temco to bench-check and troubleshoot all missile subsystems at overhaul and repair depots.
- Ground handling equipment manufactured by Temco to handle missile sections and assembled missiles on board ship and at overhaul and repair depots; provide means of loading missiles to arm launching aircraft.
- Missile section package units manufactured by The Williamson Company, Madison, Ind. to provide environmental protection during shipment and storage.

more on page 82



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Why a KIN TEL System? First, it is designed to work continuously, faultlessly even under extreme environmental conditions. Second, it is fully automatic...provides 1% linearity and continuous self-adjustment for light-level variations up to 2000:1. Third, it features crisp, photoprint picture quality—*twice* the resolution of the best home TV reception.

This basic TV system, consisting of camera, camera control, and receiver, is surprisingly low in cost, easy to operate, and simple to maintain. A complete line of housings and accessories permits observation of nearly every kind of operation, under all kinds of conditions.

Nationwide factory-trained engineering representatives can show you how a KIN TEL TV System can be put to profitable use in your business. Write direct for TV catalog 6-103 and the name of your nearest representative.

*KIN TEL manufactures closed circuit TV, and electronic instruments for measurement and control. Representatives in all major cities.*

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- RAYTHEON
- AMERICAN POTASH AND CHEMICAL
- SANDIA CORPORATION
- JOHNS HOPKINS UNIVERSITY
- SHELL DEVELOPMENT
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Mr. C. C. LaVene  
Box 621-R  
Douglas Aircraft Company, Inc.  
Santa Monica, Calif.

## SYSTEMS & SUBSYSTEMS

**F8U-2 CRUSADER:** Chance Vought Aircraft, Inc., Dallas, Texas.

- CVTS-103 bench test set manufactured by CVA to check dynamic operation of complete flight stabilization and trim system and all of its components, such as gyros, accelerometers, electromechanical and electro-hydraulic actuators and amplifiers.

- CVTS-102 portable damper test set manufactured by CVA to perform pre-flight tests on the flight stabilization and trim system.

- CVTS-105 portable test set manufactured by CVA to check dynamic operations of the yaw and roll actuators and their component parts.

- Rocket pack test set manufactured by CVA to check firing current, firing sequence and stray voltage in rocket system.

- Airstream directional reference system test set manufactured by CVA to check attack and yaw system input to armament computer.

**F-100A, -C, -D, -F:** North American Aviation, Inc., International Airport, Los Angeles 45, Calif.

- Tachometer engine thermocouple test set manufactured by B&H Instrument Co., Fort Worth 7, Texas to test thermocouple tachometer systems.

- Yaw and pitch damper test assembly manufactured by North American Aviation to test system operation.

- Engine ground handling package, hydraulic test stands, engine removal package, and aft fuselage installation adapter package manufactured by NAA.

**F-101 VOODOO:** McDonnell Aircraft Corp., St. Louis, Mo.

- McDonnell automatic checkout system (MACS) used to predict the flight acceptability of the integrated weapon system and to record control measurements and performance evaluation.

**F-102 DELTA DAGGER:** Convair, San Diego 12, Calif.

- Pneumatic system manufactured by Joy Mfg. Co., Pittsburgh, Pa. to supply high pressure air.

- Fire control ventilating system manufactured by American Electronics, Inc., Los Angeles, Calif. and KECO Industries, Inc., Cincinnati, Ohio to provide cool air for ground operation.

- Conditioning system manufactured by Herman Nelson Co. to provide heat for low temperature ventilating system operation.

- Armament ground handling system manufactured by Convair, to provide rapid transportation of missiles and rockets.

- Engine ground handling system manufactured by Convair to provide for installation, removal and transportation.

- Hydraulic ground power system manufactured by Sprague Engineering Corp., Gardena, Calif.; Sun Electric Corp., Chicago, Illinois and Arnolt Corp., Warsaw, Ind.

- Electric power system manufactured by Ideal Electric & Mfg. Co., Mansfield, Ohio.

- Pilot's artificial feel system manufactured by Convair to measure and

indicate performance of the elevator and rudder artificial feel system.

**F-104 Starfighter:** Lockheed Aircraft Corp., Burbank, Calif.

- Mobile test facility manufactured by Hallamore Electronics, Los Angeles, and Radio Phone, Los Angeles, for rapid checkout of AN/ASG-14 fire control system, automatic indication of faulty components.

- Cabin and electronic compartments pressurizer manufactured by Lockheed for pressure testing.

- Flight control system equipment manufactured by Lockheed to check control stick force vs control surface movement to detect any malfunction in system.

- Mobile kit test unit manufactured by Firewel, Buffalo, N. Y. to check operation of survival kit oxygen regulator at ground level and simulated altitude.

**F-105:** Republic Aviation Corp., Farmingdale, N.Y.

- AN/APS-54 radar bench-test and maintenance set (A&E Sqdn) manufactured by Republic. Contains complete operational mockup and test equipment to permit radar calibration, performance checks and trouble shooting.

- Integrated flight instrument system isolation tester (A&E Sqdn) manufactured by Republic. Simulates input systems would receive during flight and indicates faulty components when malfunction occurs.

- J-4 compass system test bench (A&E Sqdn) manufactured by Republic to calibrate and trouble shoot the system.

- Nose wheel steering test kit (CM Sqdn) manufactured by Republic to inspect and rig the Bendix nose wheel steering for proper operation.

- M-61 gun control tester (A&E Sqdn) manufactured by Republic for functional testing and trouble shooting the gun control box either in the aircraft or on the bench.

- Silver zinc battery tester (TAC Sqdn) manufactured by Republic for individual cell and total battery voltage.

- AF/442G1 flight control test benches (A&E Sqdn) manufactured by Republic. A set of two mobile benches contains complete mock-up and test equipment for testing, calibrating or repairing autopilot components.

- Central air data computer bench test (A&E Sqdn) manufactured by Republic to check components or complete Bendix air data computer.

- AN/ASG-19 fire control system preflight tester (A&E Sqdn) manufactured by General Electric, Johnson City, New York to perform rapid preflight checkout of major subsystems.

- AN/ASG-19 fire control system test benches (A&E Sqdn) manufactured by Republic. Set of eight mobile benches contains a complete mock-up of the fire control system and test equipment for component testing, calibration, malfunction isolation, and system check.

- AN/ASQ-37 communication-identification-navigation system mobile radiating facility (RADFAC) test unit (A&E Sqdn).

more on page 85

# Air brake for a spaceliner



The earth's atmosphere, one of the biggest obstacles to getting into outer space, can be one of our biggest assets coming back. At Douglas we are investigating how we can use its braking effects on rockets returning from deep space trips at far faster than ICBM speeds. Success will allow us to increase payloads by reducing the weight of soft landing systems. This technique also will aid us in pinpointing landing areas. Current reports show real progress. Douglas is engaged in intensive research on every aspect of space planning, from environmental conditions on other planets to the destroyer-sized space ships necessary to get there. We invite qualified engineers and scientists to join us. Some of our immediate needs are listed in the column on the facing page. Please read it.

Arthur Shef, Chief, Advanced Design Section, Missiles and Space Systems, irons out a problem with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**





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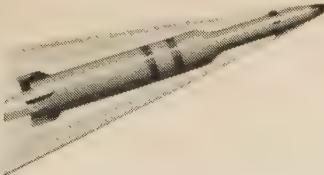
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SPACE/AERONAUTICS

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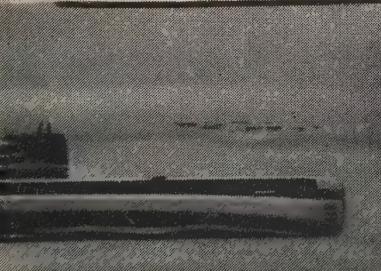
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## SYSTEMS & SUBSYSTEMS

Sqdn) manufactured by Republic. Automatically programs a complete test checkout of the CIN system in the aircraft in less than one minute. RADFAC has a range of two miles.

- AF/A42G1 flight control system line maintenance tester (A&E Sqdn) manufactured by General Electric, Johnson City, N.Y., to check proper operation or isolate malfunctions.

**F-106 DELTA DART:** Convair, San Diego 12, Calif.

- Pneumatic ground system manufactured by Convair to pressurize the missile launching system for slow operation.

• Electric load bank system manufactured by United Mfg. Co., Cleveland, Ohio for checking the several prime forms of electric power produced in the airplane or ground power electric cart.

• Electric ground power system manufactured by Wolverine Diesel and Beech Aircraft Corp., Wichita, Kansas to provide controlled electric power for maintenance and operational tests.

• Fire control air data computing system manufactured by Convair to provide total and static pressures for simulating altitude and air speed to test system.

• Fuel system ground equipment, manufactured by Convair to provide rapid preflight and component fault isolation.

**GAM-77 HOUND DOG:** North American Aviation, Missile Div., 12214 Lakewood, Downey, Calif.

• Ground handling system manufactured by Coleman Engineering, Torrance, Calif., for lifting and trailer transport. All other major GSE items—including automatic checkout equipment—are produced by NAA.

**GAR-1, -2, -3 FALCON:** Hughes Aircraft Co., Culver City, Calif.

• Falcon checkout and maintenance equipment (model DFSP for GAR-1, GAR-2, and EGSP for GAR-3) manufactured by Hughes to check tactical readiness of missile, including dynamic checkout of guidance and control parameters; provides diagnostic capability for maintenance and repair.

**HAWK:** Raytheon Company, Waltham, Mass.

• Launcher manufactured by Northrop Corp., Hawthorne, Calif.  
• Loader manufactured by Northrop and Food Machinery & Chemical Corp.  
• Storage pallets manufactured by Fruehauf Trailer Co., Detroit, Mich.  
• Shipping containers manufactured by Williamson Co., Madison, Ind.

**JUPITER:** Chrysler Corp., Missile Div., P.O. Box 2628, Detroit 31, Mich.

• System checkout and fire control equipment manufactured by Chrysler for guidance and control system check, propulsion and pneumatic check, networks check, pre-setting and fire control.

• Component checkout equipment manufactured by Chrysler to check guidance and control components, distributors, actuators, inverters and programmers.

**KC-135:** Boeing Airplane Company, Seattle, Wash.

- Pressurized cabin leakage tester

more on page 87

## BASIC BUILDING BLOCKS FROM KEARFOTT



### 20 Second Synchro

This synchro, just one of a broad line offered by Kearfott, provides the extreme accuracy required in today's data transmission systems. Kearfott synchro resolvers enable system designers to achieve unusual accuracy without the need for 2-speed servos and elaborate electronics. By proper impedance matches, up to 64 resolver control transformers can also operate from one resolver transmitter.

TYPICAL CHARACTERISTICS		SIZE 26
Type	Resolver	Control Transmitter Transformer
Part Number	Z5161-001	Z5151-003
Excit. Volts (Max.)	115	90
Frequency (cps)	400	400
Primary Imped.	400/80°	8500/80°
Secondary Imped.	260/80°	14000/80°
Transform. Ratio	.7826	1.278
Max. Error fr. E.Z.	20 seconds	20 seconds
Primary	Rotor	Stator

Write for complete data.

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**INNERCORES!** Pick your metal: brass, 356 alloy bronze, 48% nickel alloy steel, monel, stainless steel; other alloys. Seamed or seamless, name the properties you need and ask TITEFLEX. Remember, we manufacture it.

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**BRAIDING!** Round wire for maximum flexibility, flat ribbon for high pressures and maximum abrasion resistance. Metals: silicon-bronze, nickel, AISI-321 stainless, copper clad steel. Remember, we manufacture it.

**FITTINGS!** Guaranteed against blow-off at specified range of temperatures and pressures. TITEFLEX engineering makes the fitting virtually part of the hose. Assemblies of any length. Remember, we manufacture it.

It's lighter!  
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It has a smaller bending radius than most competitive hose. Yet TITEFLEX quality is so perfectly controlled that its features meet or surpass the really tough specifications. And TITEFLEX flexible metal hose is available with innercores and braid of many superior metals and alloys to match your needs.

Get more freedom in your designs . . . where fluids are carried between connecting parts of equipment or machinery . . . between misaligned parts . . . where you wish to absorb vibration . . . or to simplify multiple bend situations.

TITEFLEX engineers can help you no matter what you demand in flexibility, operating temperatures, fluid media, or pressure ratings. Ask your TITEFLEX distributor in the Yellow Pages, or write direct.

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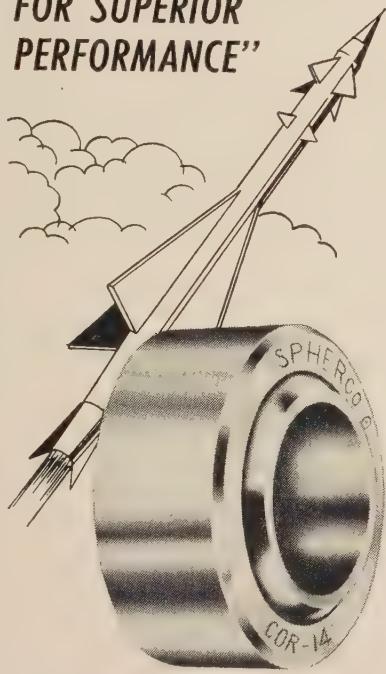
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SPACE/AERONAUTICS

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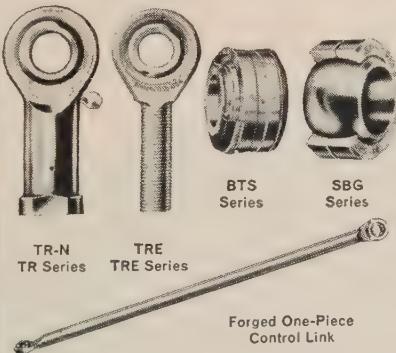
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October 1959

### SYSTEMS & SUBSYSTEMS

manufactured by Arnolt Mfg. Co., Indianapolis, Ind. to pressurize cabin for functional test of cabin pressure control system.

- Aircraft fuel system components test facility manufactured by Pacific Airmotive Corp., Burbank, Calif. for overhaul and functional test of fuel system components—valves, regulators, etc.

- Oil system components test stand manufactured by Pacific Airmotive Corp. for overhaul and functional test of oil systems components.

- Beacon radio test set manufactured by Sperry Microwave Electronics Co., Clearwater, Fla. to test, evaluate and trouble-shoot system.

- Cargo loading kits and traverser manufactured by Associated Co., Inc., Wichita, Kansas (frame) and O & M Machine Co., Los Angeles, Calif., to pick up cargo, lift it through door, position it on rails and transport it along aircraft bed.

- Air refueling boom for electrical tester assembly manufactured by Boeing Airplane Co., Seattle, Wash. to check air refueling boom for correct positioning; check positioning indicators, etc.

- Aircraft hydraulic system components test stand manufactured by Arnolt Mfg. Co., Indianapolis, Ind. for overhaul and functional testing of systems components, such as valves, pump assemblies, hydraulic pumps, etc.

- Universal control systems tester manufactured by United Control Corp., Seattle, Wash. for checking out cabin temperature control system and window anti-ice system.

- Engine pressure ratio system tester manufactured by AiResearch Mfg. Co., Los Angeles, Calif. to check system for proper operation and leakage.

**MACE:** The Martin Company, Baltimore 3, Md.

- Basic missile checker (BMC) manufactured by Martin for quantitative check of flight control system and to isolate malfunctions.

- Automatic ATRAN nose checker (AANC) manufactured by Goodyear Aircraft Corp., Akron, Ohio for quantitative test of guidance system; simulates flight conditions for dynamic test.

- Automatic powerplant checker (APPC) manufactured by Martin to check out operation of engine and components and to isolate malfunctions.

- Missile preflight tester (MPT) manufactured by Bendix Radio Div., Towson, Md., as a self-contained unit for final prelaunch checkout and semi-automatic control of launching sequence.

**POLARIS:** Lockheed Missile & Space Division, Sunnyvale, Calif.

- Missile automatic checkout and readiness equipment (ACRE) manufactured by LMSD and Packard-Bell Electronics Corp., Los Angeles, Calif. for manufacturing production test and checkout.

- ACRE manufactured by LMSD and Nortronics Div., Northrop Corp., Hawthorne, Calif. for missile stockpile maintenance and assembly test and checkout.

- ACRE manufactured by LMSD and Nortronics for missile service maintenance and re-supply test and checkout.

- ACRE manufactured by LMSD and Nortronics for missile system monitoring and tactical prelaunch checkout.

more on page 89

## BASIC BUILDING BLOCKS FROM KEARFOTT



### Analog-to-Digital Converters

Kearfott's rugged shaft position-to-digital converters are resistant to high shock and vibration and high and low temperature environments. Ideally suited for missile applications, these converters are available for many uses, including latitude, longitude, azimuth or conventional angular shaft displacement conversion and decimal count conversion. Exclusive drum design provides large conversion capacity in smallest size. Combination counter converter assemblies for both visual and electrical readout also available.

#### TYPICAL CHARACTERISTICS

Kearfott Unit No.	P1241-11A
Code	Cyclic Binary
Range	0-32,768 (2 <sup>15</sup> )
Bits per Revolution	16
Revolutions for Total Range	2,048
Volts D.C.	10.5
Current (ma.)	20
Inertia (gm. cm. <sup>2</sup> )	20
Unit Diameter (in.)	1 <sup>1</sup> / <sub>16</sub>
Unit Length (in.)	3
Life	10 <sup>6</sup> Revolutions or 10 <sup>3</sup> hours
Static Torque (in.-oz.)	2 (break) 1 (running)
Weight (oz.)	5
Maximum Speed (RPM)	600

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# GPL combined guidance

## A.I.D. Navigation Systems

Combining state-of-the-art equipment in several fields to create new and superior systems for aircraft and missile guidance is still another GPL capability. One case in point is GPL's Astro-Inertial-Doppler A.I.D. navigation system—a stellar monitored, doppler tuned and damped inertial system—in which each element refines the others, and the system as a whole provides far greater inherent accuracies.

A.I.D. and other combined guidance and integrated systems now under development at GPL are particularly significant because they utilize existing systems and elements, existing components of proven reliability and accuracy, existing techniques for manufacture and maintenance. Yet continuing study of progress in the state of the art and continuing study of new system concepts keep these systems as advanced as the aircraft and missiles they will guide.

Why not put GPL's talents, and complete "research through customer service" facilities to work for you?

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GENERAL PRECISION LABORATORY INCORPORATED, Pleasantville, N.Y.

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**REDSTONE:** Chrysler Corp., Missile Div., P. O. Box 2628, Detroit 31, Mich.

- System checkout and fire control equipment manufactured by Chrysler for guidance and control system check, propulsion and pneumatic check, networks check, pre-setting and fire control.

- Component checkout equipment manufactured by Chrysler to check guidance and control components, distributors, actuators, inverters and programmers.

**REGULUS I:** Chance Vought Aircraft, Dallas, Texas.

- AN/DSM-4B servicing system manufactured by CVA for preflight test and fixed installation launch.

- AN/DSM-25 and AN/DSM-26 servicing systems manufactured by CVA for preflight test and mobile installation launch.

- AN/DSM-28 radar command system test set manufactured by CVA for preflight loop check.

- AN/DSM-49 missile response simulator manufactured by CVA for GSE evaluation.

- AN/DRM-1 radio command unit tester manufactured by CVA for bench test and fault isolation.

- AN/DPM-1 radar command unit tester manufactured by CVA for bench test and fault isolation.

- AN/DSM-20 autopilot and stabilization checkout system manufactured by CVA for bench test and fault isolation of components.

- CUXTS-179 radio command unit evaluator manufactured by CVA for automatic evaluation of radio command components.

**SIDEWINDER:** Philco Corp., Philadelphia 44, Pa.

- Guidance and control unit pen recorder type checkout equipment manufactured by Philco to test out tracking loop and guidance control.

- Guidance and control unit go-no-go checkout equipment manufactured by Philco to check tracking loop and guidance control.

**SPARROW:** Raytheon Company, Waltham, Mass.

- DSM-32 missile test equipment manufactured by Dumont to check missile system firing readiness.

**THOR:** Douglas Aircraft Co., Inc., Santa Monica, Calif.

- AN/MSQ-23 launching countdown group: electronic equipment trailer manufactured by Fruehauf Trailer Co., Detroit 32, Mich., and electronic subassemblies manufactured by North Electric, Packard-Bell Electronics, General Electric, C. G. Hokanson, Altec Lansing, and United Control.

- SMU-14/M launching equipment simulator checkout trailer manufactured by Fruehauf and electronic subassemblies manufactured by North Electric, Packard-Bell, Hokanson, General Electric, and Douglas.

- JEU-2/M power switchboard trailer manufactured by Fruehauf and electrical subassemblies manufactured by North Electric, General Electric, Hokanson, and Douglas.

- TTU-36/M missile system checkout station trailer manufactured by Fruehauf and electronic subassemblies

manufactured by Amelco, Packard-Bell, General Electric, Hokanson, North Electric., and Douglas.

**TITAN:** The Martin Company, Denver, Colo.

- R & D checkout and launch control equipment manufactured by Martin including master operational controller; communications and TV systems; ground power system; and propellant loading systems and controller.

- R & D mechanical GSE manufactured by Martin for ground hydraulic power, air conditioning, thrust and weight measurement, missile handling, erection and servicing. Includes missile transportation vehicles, propellant loading and high pressure gas systems and missile maintenance equipment.

- Operational checkout and launch control equipment manufactured by Martin to sequence missile system through countdown and launch operations. Performs go-no-go checks on propellant loading and pressurization system, flight control system, engine control system, accessory system and re-entry vehicle system. Includes electrical ground power equipment and electrical and electronic maintenance equipment.

- Operational mechanical GSE manufactured by Martin for ground hydraulic power, air conditioning, and umbilical servicing. Includes missile transportation vehicles, propellant loading system compressors, vaporizers, filters and fill connectors.

**W2F-1:** Grumman Aircraft Engineering Corp., Bethpage, N.Y.

- Airborne early warning system automatic checkout equipment (test center) manufactured by Autonetics Div. of North American Aviation, Downey, Calif., to pinpoint the source of any malfunction to a replaceable subassembly. Automatic checkout equipment adapters manufactured by Airborne Equipment Mfg.

- Airborne early warning system in-flight performance monitor manufactured by General Electric, Utica, N.Y. and Litton Industries, Beverly Hills, Calif. for crew to determine the level of system performance and for fault isolation.

**X-15:** North American Aviation, Inc., International Airport, Los Angeles 45, Calif.

- Propulsion system ammonia servicing trailer manufactured by Fruehauf Trailer Co., Los Angeles, Calif., to supply and service rocket fuel system.

- Mobile refrigeration system manufactured by Kohlenberger Eng. Co. cools ammonia during fueling.

- Hydraulic system test stand manufactured by Sprague Engineering Co., Los Angeles, Calif. used to test system operation.

- Stability augmentation system ground test system manufactured by Westinghouse Electric, Baltimore, Md. to test SAS electronics.

- Closed TV test monitoring check system manufactured by Hallamore Electronics, Buena Park, Calif. to evaluate system performance.

- Stable platform test set manufactured by Sperry Gyroscope Co., Great Neck, N.Y. to test platform operation.

- Maintenance servicing trailer, ground run-up thrust stand, hydrogen peroxide trailer, and helium chilling trailer made by NAA.

## BASIC BUILDING BLOCKS FROM KEARFOTT



### Integrating Tachometers

Kearfott integrating tachometers, special types of rate generators, are almost invariably provided integrally coupled to a motor. They feature tachometer generators of high output-to-null ratio and are temperature stabilized or compensated for highest accuracy integration and rate computation. Linearity of these compact, lightweight tachometers ranges as low as .01% and is usually better than  $\pm .1\%$ .

### TYPICAL CHARACTERISTICS

Size 11  
(R860)

Excitation Voltage (400 cps)	115
Volts at 0 rpm (RMS)	.020
Volts at 1000 rpm (RMS)	2.75
Phase shift at 3600 rpm	0°
Linearity at 0-3600 rpm	.07
Operating Temperature Range	-54° +125°

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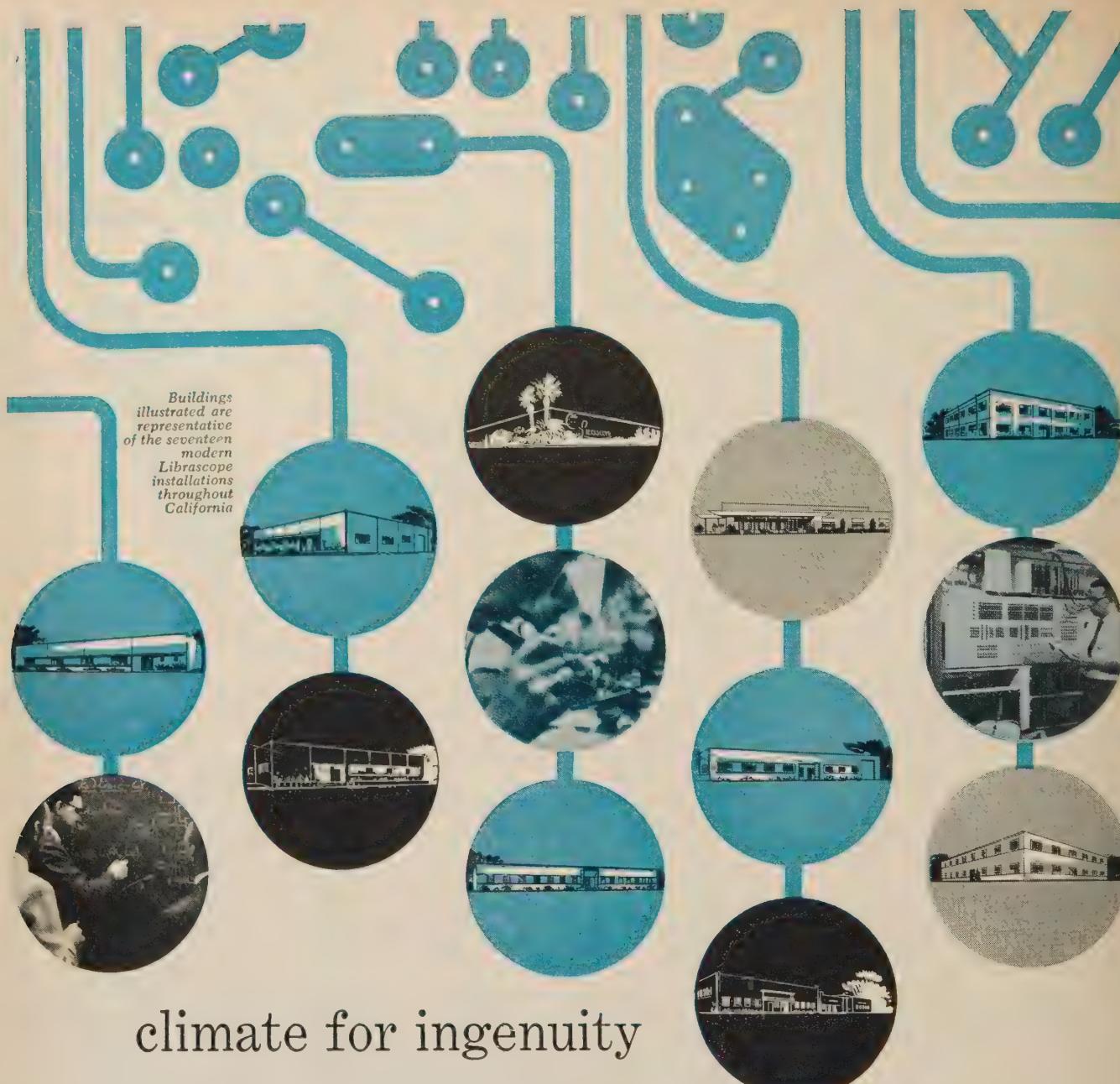
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*Buildings illustrated are representative of the seventeen modern Librascope installations throughout California*

## climate for ingenuity

'Facilities' is more than a masonry-and-steel term at Librascope...it represents an overall regard for the tools of creative engineering—climate, time, equipment.

'Facilities' also mean the coordinated efforts of skilled people working in seventeen modern Librascope installations throughout California.

For more than 20 years, Librascope has been recognized as a leader in the development of controls, computers and components...answering military and commercial requirements with timeliness and ingenuity.

Today, Librascope's 'facilities' continue to grow at a rapid pace...providing an ever-expanding climate for ingenuity.

*For information on career opportunities, write Glen Seltzer, Employment Manager.*

L1 9-19

For details on how Librascope  
can anticipate and solve your  
computer and control problems,  
you are invited to write:



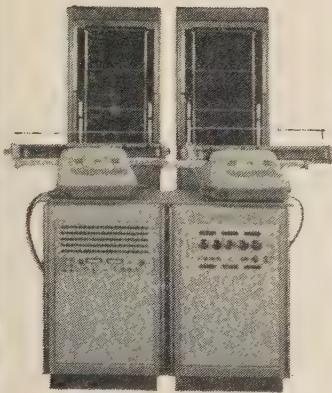
A  
**GENERAL  
PRECISION  
COMPANY**

LIBRASCOPE, INC. • 808 WESTERN AVENUE • GLENDALE, CALIF. • A Subsidiary of General Precision Equipment Corporation

Write in No. 40 on Reader Service Card at start of Product Preview Section

SPACE/AERONAUTIC

# BASIC BUILDING BLOCKS FROM KEARFOTT



## Data Logging

Kearfott's broad line of test equipment includes the Scanalog 200-Scan Alarm Logging System which monitors, logs and performs an alarm function of up to 200 separate temperature, pressure, liquid level or flow transmitters. This precise data handling system is equipped with manual controls for scanning rates, automatic or manual logging, data input relating to operator, time, day, run number and type of run. 200 numbered lights correspond to specific points being maintained and provide a visual "off normal" display for operator's warning. System can be expanded to 1024 points capacity and 2000 points per second scanning rate.

*Write for complete data.*

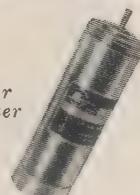
Analog  
Digital  
Converter



20 Second  
Synchro



Integrator  
Tachometer



**Engineers:** Kearfott offers challenging opportunities in advanced component and system development.

**Write in No. 41 on Reader Service Card at start of Product Preview Section**

# BASIC BUILDING BLOCKS FROM KEARFOTT



## Floated Rate Integrating Gyros

Specifically designed for missile applications, these Kearfott miniature gyros operate efficiently at unlimited altitudes. Their outstanding accuracy and performance make them superior to any comparably-sized units on the market. Hermetically sealed within a thermal jacket, these gyros are ruggedly designed and completely adaptable to production methods. Performance characteristics that are even more precise can be provided within the same dimensions.

### TYPICAL CHARACTERISTICS

#### Mass Unbalance:

Along Input Axis:  $1.0^\circ/\text{hr}$   
maximum untrimmed

Standard Deviation (short term):  
Azimuth Position:  $0.05^\circ/\text{hr}$   
Vertical Position:  $0.03^\circ/\text{hr}$

#### Drift Rate Due to Aniselasticity

Steady Acceleration:  
 $.015^\circ/\text{hr.}/\text{g}^2$  maximum

Vibratory Acceleration:  
 $.008^\circ/\text{hr.}/\text{g}^2$  maximum

#### Damping:

Ratio of input angle to  
output angle is 0.2

Characteristic Time:

.0035 seconds or less

Weight: 0.7 lbs.

Warm-Up Time:

10 minutes from  $-60^\circ\text{F}$

Life: 1000 hours minimum

# BASIC BUILDING BLOCKS FROM KEARFOTT



## Electrohydraulic Servo Valve

Kearfott's unique approach to electrohydraulic feedback amplification design has resulted in a high-performance miniature servo valve with just two moving parts. Ideally suited to missile, aircraft and industrial applications, these anti-clogging, 2-stage, 4-way selector valves provide high frequency response and proved reliability even with highly contaminated fluids and under conditions of extreme temperature.

### TYPICAL CHARACTERISTICS

Quiescent Flow ..... 0.15 gpm

Hysteresis ... 3% of rated current

Frequency Response ..... 3 db @ 100 cps

Supply pressure....500 to 3000 psi

Temperature-Fluid & Ambient

.....  $-65^\circ\text{F}$  to  $+275^\circ\text{F}$

Flow Rate Range .... .3 to 10 gpm

Weight ..... 10.5 ounces

*Write for complete data.*

**Kearfott**

A  
**GENERAL  
PRECISION  
COMPANY**

**KEARFOTT COMPANY, INC., LITTLE FALLS, N.J.**

A subsidiary of General Precision Equipment Corporation  
Sales and Engineering Offices: 1500 Main Ave., Clifton, N.J.  
Midwest Office: 23 W. Calendar Ave., La Grange, Ill.  
South Central Office: 6211 Denton Drive, Dallas, Texas  
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

# TRUE PORTABILITY

is why one man can service aircraft  
or missiles in minutes with Cornelius  
ground support air compressors



Model 3790109  
7 SCFM — 150 psi



Model 3260101  
3.5 SCFM — 2000 psi



Model 3750303  
3.5 SCFM — 3000 psi



Model 130R1409  
2 SCFM — 3000 psi



Model 3800100  
4 SCFM — 3000 psi



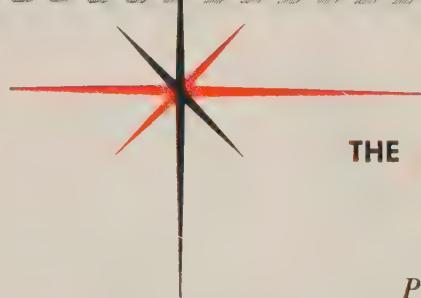
Model 130R3500  
2 SCFM — 3000 psi

Cornelius ground support air compressors are light enough to be handled by one man but don't let their small size deceive you! When it comes to performance they provide pressures up to 3000 psi and air delivery up to 4 SCFM. Cornelius compressors can often be wheeled into service and complete jobs faster and easier than motorized equipment. They are ideal for "retriever" service because they are easily and economically flown to stranded aircraft.

A complete Cornelius ground support service system includes compressor, moisture separator, oil filter, inlet filter, relief valve, pressure gauge and high pressure hose. Pressure reservoirs, back pressure valve, pressure regulators and chemical driers are optional. Gasoline engine drive, hydraulic or electric motor drive as well as turbine drive can be used to power Cornelius equipment. All U. S. military services use Cornelius compressors. Aircraft, missile, flame thrower and underwater demolition support are a few of their current applications.

Cornelius also manufactures compressors only, for mounting on your own multi-purpose ground support carts. In addition, a complete line of small industrial compressors (up to 3000 psi discharge pressure) for OEM, lab work, production test work and maintenance are available.

For true portability, one man operation and reliability in a small, compact, low cost ground support compressor, talk with a Cornelius sales engineer or write today for more information.



THE **Cornelius** COMPANY  
AERO DIVISION

553 - 39th Avenue N. E. • Minneapolis 21, Minnesota

Pioneers in pneumatic systems for aircraft.

Write in No. 42 on Reader Service Card at start of Product Preview Section.

SPACE/AERONAUTICS

nuclear	systems & subsystems	COMPANY CAPABILITIES
checkout	scale	go-no-go testing

## GSE company capabilities

This listing is based on a survey of over 1500 companies taken from "Missile Sub-Contracting," a publication of the Office of Procurement and Technical Assistance in the Small Business Administration. Each of the surveyed companies was asked to list its GSE specialties, a limited number of its recent GSE contracts, and literature on its GSE capabilities.

All companies that responded to SPACE/AERONAUTICS' survey in time and whose activities are covered by the Air Force's definition of GSE (as embracing all ground operations, handling, and servicing equipment for aircraft, missiles, and spacecraft) are included in this listing. The card numbers given with the literature listings refer to the Reader Service Card opposite page 247. With this Card, you can

easily obtain any of the literature offered.

In the opinion of the editors, the government publication on which SPACE/AERONAUTICS' survey was based provides by far the most comprehensive current listing of companies active in the GSE field. Nevertheless, even this listing may not be 100 per cent complete. Companies that believe they have been incorrectly omitted from the listing below therefore are invited to submit the information requested in SPACE/AERONAUTICS' original survey (see above) by October 23 at the latest. Any such information—which should be addressed to Reprint Dept., SPACE/AERONAUTICS, 205 E. 42nd St., New York 17, N.Y.—that qualifies for inclusion will be added to the reprint version of this listing.

**ACF INDUSTRIES, INC.**, 750 Third Ave., New York 17, N.Y.

- **GSE SPECIALTIES**—Complete GSE engineering and production programs including handling, launching, and automatic checkout of aircraft and missile weapon systems and subsystems.

- **GSE CONTRACTS**—Snark mobile launcher; Bell Rascal handling transporter; nuclear support equipment for Kiwi A rocket engine (part of AEC's Rover and Pluto nuclear rocket and ramjet propulsion support equipment program (includes development of a remotely controlled railroad flatcar); F-101-B analog computer (nucleus of McDonnell Automatic Checkout System).

- **GSE LITERATURE** — Voodoo Magic (No. 600 on Card); Man-Machine Data Link (No. 601 on Card); Typical Weapons Support Project (No. 602 on

Card); Mark VII Bomb Trailer (No. 603 on Card); Specialized Trailers MF-10 (No. 604 on Card).

**ADLER ELECTRONICS INC.**, 1 Le Fevre Lane, New Rochelle, N.Y.

- **GSE SPECIALTIES** — automatic electronic missile test and checkout equipment. Also ship-board missile test equipment.

- **GSE CONTRACTS**—Ford Instrument, Arma-Division of American Bosch Arma, Inc., General Electric, McDonald Aircraft, Convair, Canadair, ITT, and RCA.

- **GSE LITERATURE**—Capabilities Brochure (No. 605 on Card).

**AEROQUIP CORP.**, 300 S.E. Ave., Jackson, Mich.

- **GSE SPECIALTIES**—Hoses of Teflon (medium and high-pressure to

24,000 psi burst) for hydraulic, fuel, pneumatic, nitric acid, and similar compound transfer. Also self-sealing couplings for ground hydraulic, pneumatic, and fuel system applications.

- **GSE CONTRACTS**—Subcontracts on Jupiter, Redstone, Thor, Bomarc, Titan, etc.

- **GSE LITERATURE**—Teflon Catalog (No. 606 on Card); Aircraft Catalog (No. 607 on Card).

**AIR PRODUCTS, INC.**, Box 538, Allentown, Pa.

- **GSE SPECIALTIES**—permanent liquid oxygen installations such as at Cape Canaveral, Santa Susana, Numbus, Edwards and Denver; trailer-mounted (1 to 20 ton/day) oxygen plants for operational missile squadrons; LOX semi-trailers (to 4000 gpm); shipboard liquid oxygen-nitrogen generators, storage tanks, and high-pressure high-capacity cryogenic liquid pumps. Also design, construction and operation of liquid hydrogen plant for tonnage production.

- **GSE CONTRACTS**—Air Force and Army semi-trailers to haul liquid oxygen from generating plants to missile pads; Navy semi-trailer-mounted helium liquefier for liquid transport test program; Air Force skid mounted liquid oxygen-liquid nitrogen generators for operational IRBM and ICBM Missile squadrons.

- **GSE LITERATURE** — General Company Brochure (No. 612 on Card).

**AIRDOX CARDOX PRODUCTS CO.**, 307 N. Michigan Ave., Chicago 1, Ill.

- **GSE SPECIALTIES**—Mobile and skid mounted high pressure compression systems for transfer and compression of helium, nitrogen, etc. Engineered units for discharge pressures of 3500 to 10,000 psig with discharge capacities to 150 scfm.

- **GSE CONTRACTS**—Partick AFB-Pan American: mobile booster compression systems; ABMA: mobile booster

more on page 96

# MA59 MINIATURIZATION AWARD

Miniature Precision Bearings, Inc., cordially invites you to participate in the 1959 Miniaturization Award competitions. The Miniaturization Award for 1959 will be presented during the spring of 1960 at the 3rd Annual Awards Dinner in New York City. The Award symbolizing Miniaturization is a bronze sculpture by a leading American artist. Certificates of Excellence will also be awarded for additional outstanding entries.

### PURPOSES

In addition to stimulating public knowledge in the industrial advancement of miniaturization, the MA 59 competition promotes national recognition of award winning companies, individuals, or organizations.

### JUDGING OF ENTRIES

Entries will be judged by an independent committee of members of the electronics, metalworking, research and publishing fields.

### ENTRIES

For a brochure giving criteria, upon which the entries are judged and other details of the competition, write Miniaturization Awards Committee, Box 604, Keene, N.H.

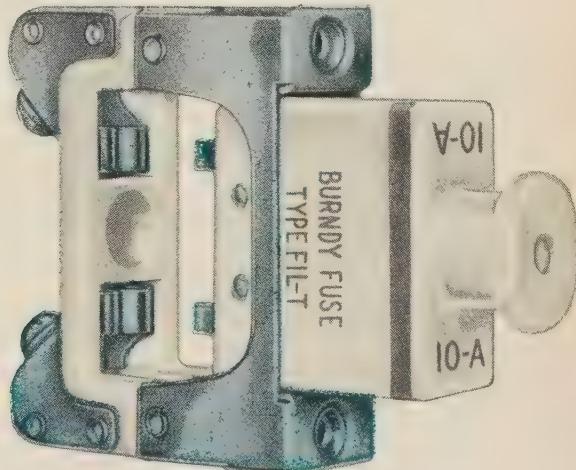
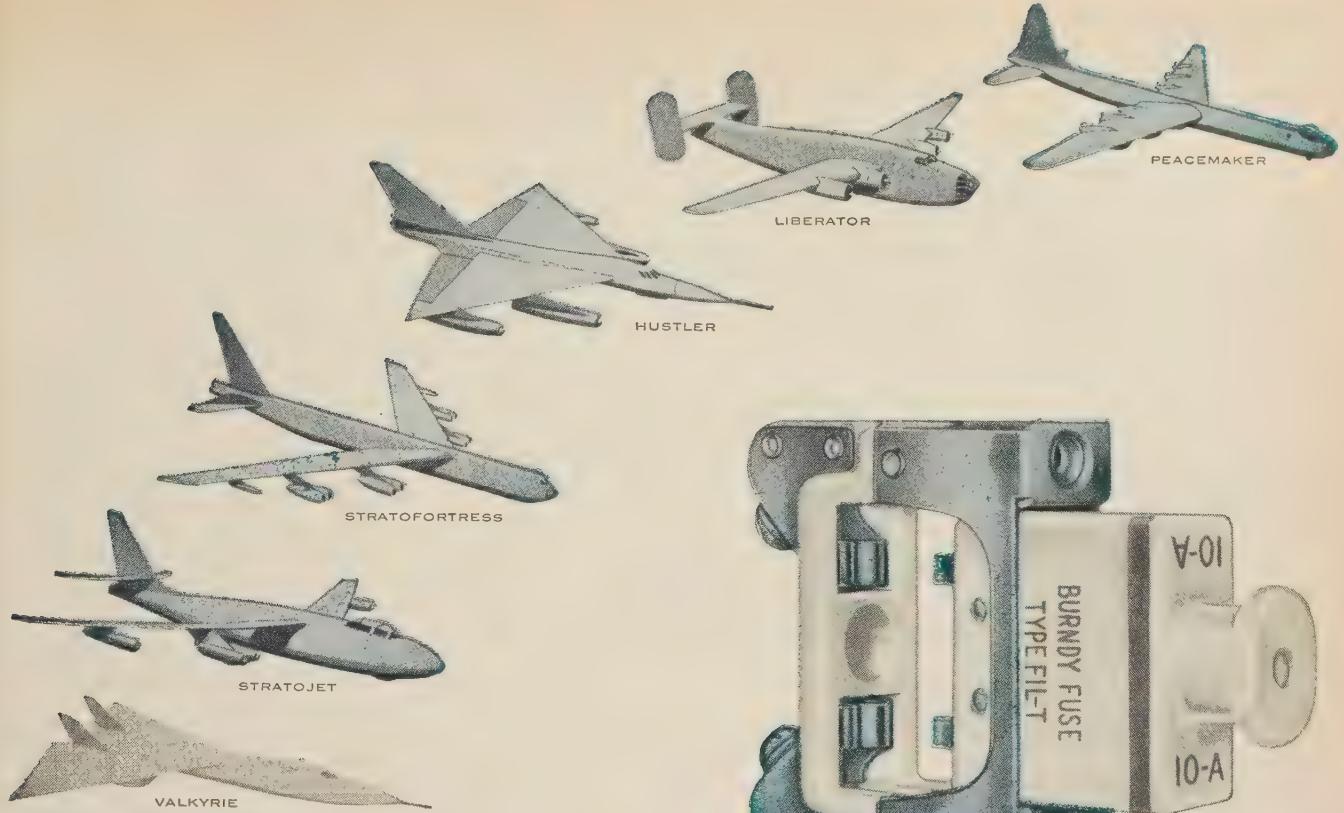
This brochure outlines the manner in which entries should be submitted and gives information on past winners. Because entries should be received by January 20, 1960, prospective entrants should secure the MA 1959 brochure as soon as possible.

**Dynamics of Flight**, by B. Etkin. Some of the topics covered in this book on stability and control are static and dynamic stability, transient and frequency response, feedback systems, dynamics of missiles and machine computations. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. \$15.

**Proceedings of the Fourth Sagamore Research Conference on High Temperature Materials, Their Strength Potentials and Limitations.** Papers presented at this meeting, co-sponsored by Ordnance Materials Research Office and Army Office of Ordnance Research, included thermal cycling and thermal fatigue, effects of high speed heating and loading, etc. Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. (Reprint PB 131834) \$5.

**High Altitude and Satellite Rockets.** A symposium held at Cranfield, England, in July '57, this includes 12 papers by British and American authors as well as a statement by B. M. Petrov of Russia on the USSR's rocket and earth satellite program for the I.G.Y. Papers cover such topics as re-entry, instrumentation, guidance, high temperature materials, etc. Philosophical Library, Inc., 15 E. 40th St., New York 16, N.Y. \$15.

**Handbook of Physics**, edited by E. U. Condon & Hugh Odishaw. This comprehensive book provides a wide range of information on the principles of physical science and the mathematics involved in their exposition. As an example, the section on electricity and magnetism includes chapters on basic electromagnetic phenomena, static electric and magnetic fields, electric circuits, electronic circuits, magnetic materials, etc. Other major sections cover the topics of mathematics, mechanics of particles & rigid bodies, mechanics of deformable bodies, heat and thermodynamics, optics, atomic physics, etc. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y. \$25.



**THEN, NOW and TOMORROW—**

*for the toughest jobs in electrical circuit protection!*

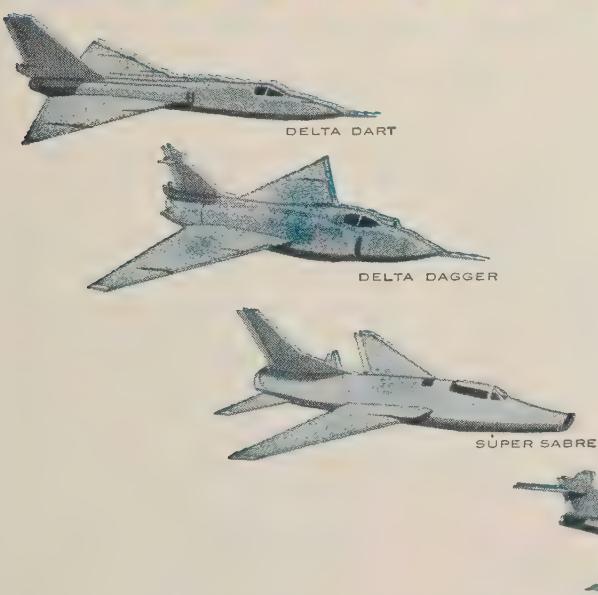
# BURNDY LIMITERS

Where reliability under extreme service conditions is imperative, airborne electrical systems are protected by Burndy LIMITERS. Here's why —

- Higher tripping temperature provides uniform, predictable performance in spite of ambient temperature variation...pinpoints the moment for protection.
- Inherently fail-safe. No mechanical parts.
- High interrupting capacity—in ratings from  $\frac{1}{4}$ A to 125A.

Indicating LIMITER (above) for dead front panel mounting, ambients up to 300°F, and visible indicating LIMITER (not shown) conform to MIL-F-5372B and MIL-F-5373B.

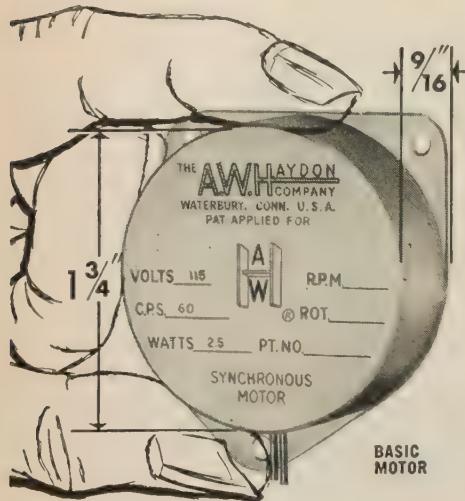
LIMITERS now in development for 600°F operation and nuclear applications.



OMATON DIVISION BURNDY NORWALK, CONNECT.; TORONTO, CANADA; IN EUROPE: ANTWERP, BELGIUM  
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# ANOTHER FIRST...

# THE ONLY Electro-Reliable



## A.C. TIMING MOTOR

*Thinner . . .  
Quieter . . .  
More Reliable . . .  
More Versatile*

### FINGER-THIN . . .

Only 9/16 Inches Short . . . Only 1 3/4 Inches in Diameter . . . very compact . . . reduces the size of your equipment.

### WHISPER-QUIET . . .

Strictly an electrical motor . . . practically noiseless . . . no rattling of gears or ratchets.

### HIGH TORQUE . . .

1/4 oz. inch at the rotor with instantaneous start and stop . . . requires only 2 1/2 watts . . . can replace larger motors in recorders, controls and telemetering equipment.

### HIGHEST RELIABILITY . . .

Longer life . . . no one-way gears or ratchets to fail . . . provides millions of operations without any trouble.

### SPECIFICATIONS

Standard Voltage Ratings:  
6, 12, 24, 115, 230 Volts  
Frequency:  
60 CPS Standard  
25, 50 CPS Available  
Power Input: 2.5 Watts  
Maximum (60 CPS)

BASIC MOTOR  
Weight: 4 ounces  
Speed: 300 RPM  
Torque: 1/4 oz-in.  
Length: 9/16 inch

WITH INTEGRAL GEAR TRAIN  
Weight: 5 ounces  
Speed: 300 RPM to 1/6 RPH  
Torque: 30 oz.-in. @ 1 RPM  
Length: 7/8 inch



WITH INTEGRAL GEAR TRAIN

© 1959

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Bulletin AWH MO-806

The  
**A.W.HAYDON Company**

223 NORTH ELM STREET, WATERBURY 20, CONNECTICUT

Custom Design & Manufacture Of Electronic And Electro-Mechanical Timing Devices

Write in No. 45 on Reader Service Card at start of Product Preview Section

### CAPABILITIES

compression systems for Jupiter; Conair Astronautics.

• GSE LITERATURE—Engineering Information and Specifications (No. 609 on Card); Hydrocarbon Content of Helium Measured with an Infra-Red Analyzer (No. 610 on Card); Cooling High Pressure Air for Water and Oil Removal (No. 611 on Card).

THE LOUIS ALLIS CO., 427 E. Stewart St., Milwaukee 1, Wis.

• GSE SPECIALTIES — mobile ground power units, missile and aircraft inverters.

• GSE CONTRACTS—AC Spark Plug; aircraft inverter.

• GSE LITERATURE — Mobile Ground Power Units (No. 613 on Card); Inverter Data Sheet (No. 614 on Card).

ALTO SCIENTIFIC CO., INC., 855 Commercial St., Palo Alto, Cal.

• GSE SPECIALTIES—Components for automatic timing and voltage monitoring; solid state power switches and portable AC voltmeters for checkout systems.

• GSE CONTRACTS—Douglas Aircraft Co., (Nike Hercules) completion October, '59; Lockheed Missiles & Space Division (Discoverer) completion September, '59; Douglas (Nike Zeus) completion June, '59.

• GSE LITERATURE—Subassembly Bulletins (No. 615 on Card).

ALUMINUM CO. OF AMERICA, 1501 Alcoa Bldg., Pittsburgh 19, Pa.

• GSE SPECIALTIES — tanks, chemical containers, specialty containers, rocket launchers, castings, forgings, wheels, impact extrusions, structural shapes, sheet, and plate mill products.

• GSE LITERATURE—Alcoa Structural Handbook (No. 616 on Card); Alcoa Aluminum Handbook (No. 617 on Card); Welding Alcoa Aluminum (No. 618 on Card); Brazing Alcoa Aluminum (No. 619 on Card); Alcoa Impacts, Metal in Motion (No. 620 on Card); Alcoa Jobbing Division Facilities (No. 621 on Card).

AMELCO, INC., 2040 Colorado Ave., Santa Monica, Cal.

• GSE SPECIALTIES — electronic missile checkout including system and component consoles for dynamic test of guidance subsystems; for testing missile inverters, rate and HIG gyros; and for testing and maintaining missile batteries.

• GSE CONTRACTS — Equipment production for Nike-Hercules and Thor missiles.

• GSE LITERATURE — Company Brochure (No. 622 on Card).

AMERICAN AIR FILTER CO., INC., DEFENSE PRODUCTS DIV., 310 Third St., Rock Island, Ill.

• GSE SPECIALTIES—design, test, and production of portable and transportable heaters; air conditioning equipment for electronic checkout field equipment.

• GSE CONTRACTS — trailer and running gear complete with filtered air intake and blower for two Minneapolis-Honeywell R & D electronic checkout carts (prototypes); air conditioning unit for mobile electronic checkout cart used to test B-58 equipment; heater for Hawk missile system.

more on page 98

SPACE/AERONAUTICS

## **DESTINATION KNOWN**

When a mighty "Thor" soars from Vandenberg Air Force Base, equipment designed and built by Packard Bell checks it out, launches it and predicts its point of impact.

### **ENGINEERING BEYOND THE EXPECTED**

The Missile Impact Predictor is one-eighth the size and was built at one-tenth the cost of previous systems.

Ground support equipment matches the reliability built into the "Thor." All combine to guarantee an effective weapon for retaliation or space exploration... destination known.

**PACKARD BELL ELECTRONICS**

Technical Products Division

12333 W. Olympic Blvd.

Los Angeles 64, Calif. BR 2-6141

Write in No. 46 on Reader Service Card at start of Product Preview Section

## CAPABILITIES



## purpose: probe

One of the 20th century's most significant events is the Cape Canaveral astronautical probe. Pan Am is proud that through our responsibilities to the Air Force in operation and maintenance of the Atlantic Missile Range, we have been active participants in the preparation and launching of every probe. We are pleased that members of our technical staff have had this opportunity to further their professional careers on projects of such significance.

Other engineers and scientists should investigate their future on the threshold of the space age with Pan Am by Addressing Mr. J. B. Apple-dorn, Director of Technical Employment, Dept. T-9.



Guided Missiles Range Division  
Patrick Air Force Base, Florida  
Check Employment Inquiry Form on Page 233

- GSE LITERATURE—Heater Testing and Qualification (No. 623 on Card); Van and Shelter Air Conditioners (No. 624 on Card); Specification Sheets (No. 625 on Card).

**AMERICAN MACHINE & FOUNDRY COMPANY, GOVERNMENT PRODUCTS GROUP**, 261 Madison Ave., New York 16, N. Y.

- GSE SPECIALTIES — complete missile launching systems including electronic and mechanical components; mobile ground handling equipment including ground carts and special loading devices; feasibility studies of launching, handling and guidance concepts.

- GSE CONTRACTS — launchers (Titan "Silo Lift" hard site launcher, Bomarc launcher, Talos launching system, and Bull Goose launcher); handling and transport equipment (Bull Goose dual purpose transporter, Bomarc air transport equipment, Talos handling carts, all-purpose handling dolly); servicing equipment (hydraulic package for Bomarc, Bomarc fueling cart, and an all-purpose missile servicing platform).

- GSE LITERATURE—"Hard Site" Missile Launching (No. 626 on Card); Ground Support Missile Activities (No. 627 on Card); AMF Overall Capability (No. 628 on Card).

**AMERICAN RESEARCH & MANUFACTURING CORP.**, 920 Halpine Ave., Rockville, Md.

- GSE SPECIALTIES—missiles and stores handling and ground checkout equipment. GSE instrumentation and count down equipment units such as amplifiers, power supplies and detection units.

- GSE CONTRACTS—Army: low frequency vibration analyzer; Navy: missile transport and load manipulator; weapon handler and loader.

- GSE LITERATURE—ARMCORP Automotive Manipulator (No. 629 on Card); ARMCORP Vibration Analyzer (No. 630 on Card).

**ANACONDA METAL HOSE DIV., THE AMERICAN BRASS COMPANY**, 698 South Main St., Waterbury 20, Conn.

- GSE SPECIALTIES—design and manufacture of flexible metal hose assemblies in bronze, steel, stainless steel and other alloys, complete with end fittings. Also, special large diameter and insulated assemblies for transfer lines from trailers to rigid piping.

- GSE CONTRACTS—ground transfer lines supplied to Redstone Arsenal, Hayes Aircraft and Chrysler Missile Division for Jupiter moon shot missile; flexible electrical wiring conduit lines supplied to Food Machinery & Chemical for Bomarc launcher; transfer lines for fuming nitric acid supplied to Firestone Tire & Rubber for Corporal pressure lines, exhaust lines and "purging" lines supplied to Douglas Aircraft for Thor.

- GSE LITERATURE — General Catalog (No. 631 on Card); Anaconda Flexible Connectors of Teflon (No. 632 on Card); Anaconda AX Tubing (No. 633 on Card); Liquid-tight Electrical Wiring Conduit (No. 634 on Card).

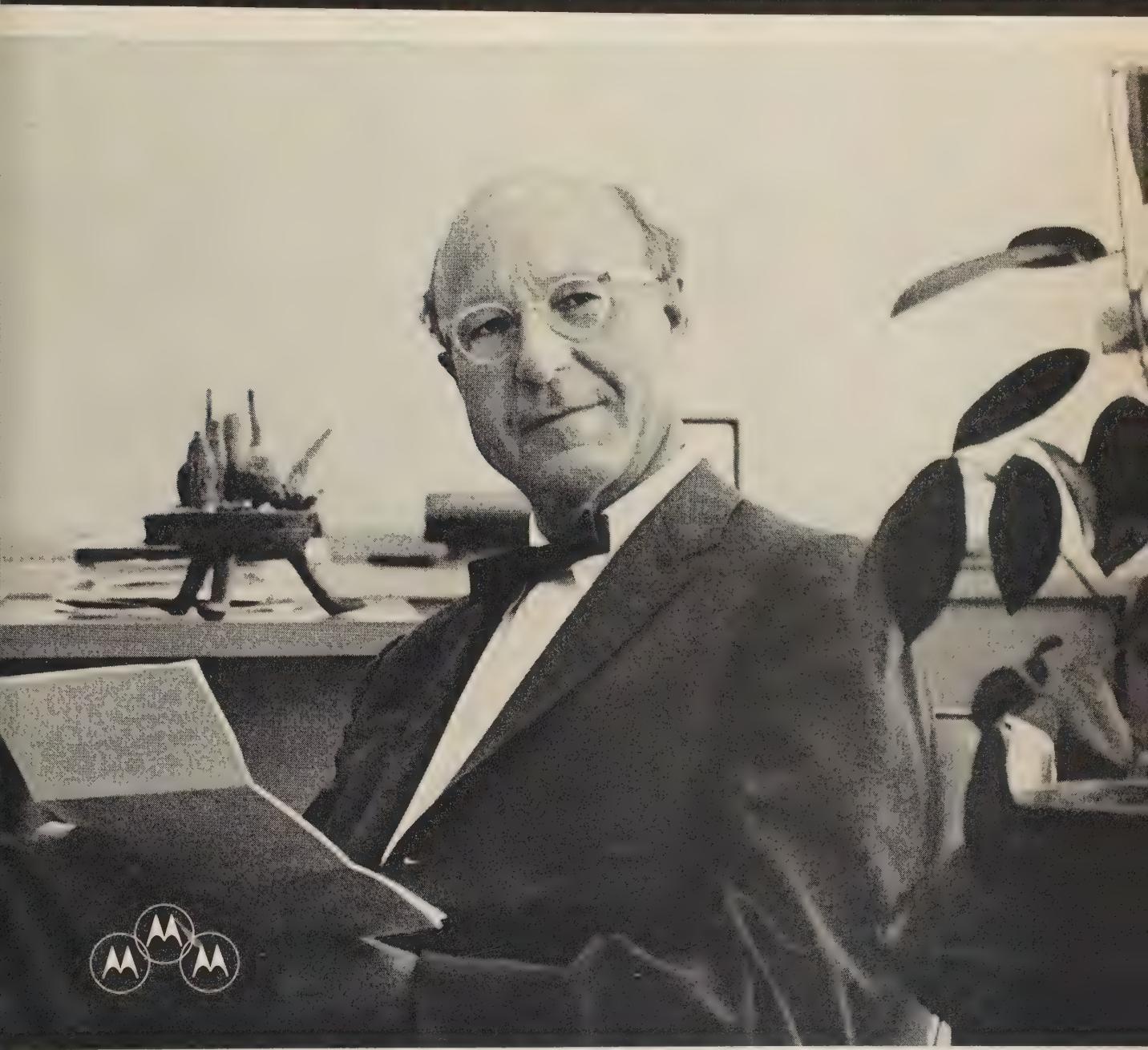
**ANDERSON, GREENWOOD & CO.**, 5425 Rice Ave., Houston 36, Tex.

- GSE SPECIALTIES—Engineering

more on page 102

SPACE/AERONAUTICS

# *Strategic Deployment of Technical Personnel*

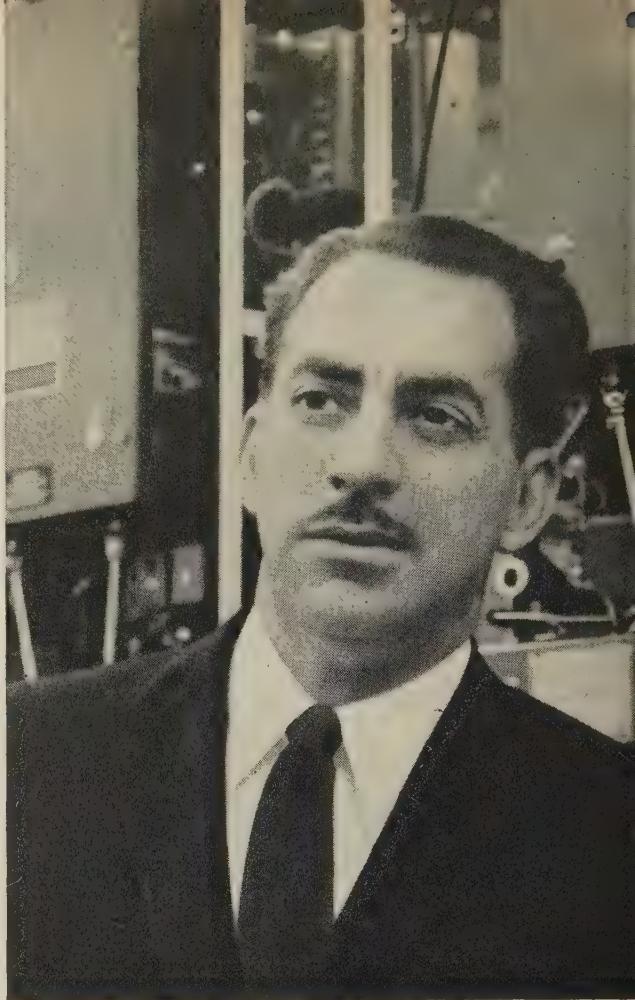


Dr. Daniel E. Noble, Executive Vice President, Motorola, Inc.

“Dynamic organization...not static...is the key to productive use of technical talent in the field of military electronics.”



William S. Wheeler, Vice President and General Manager  
Military Electronics Division



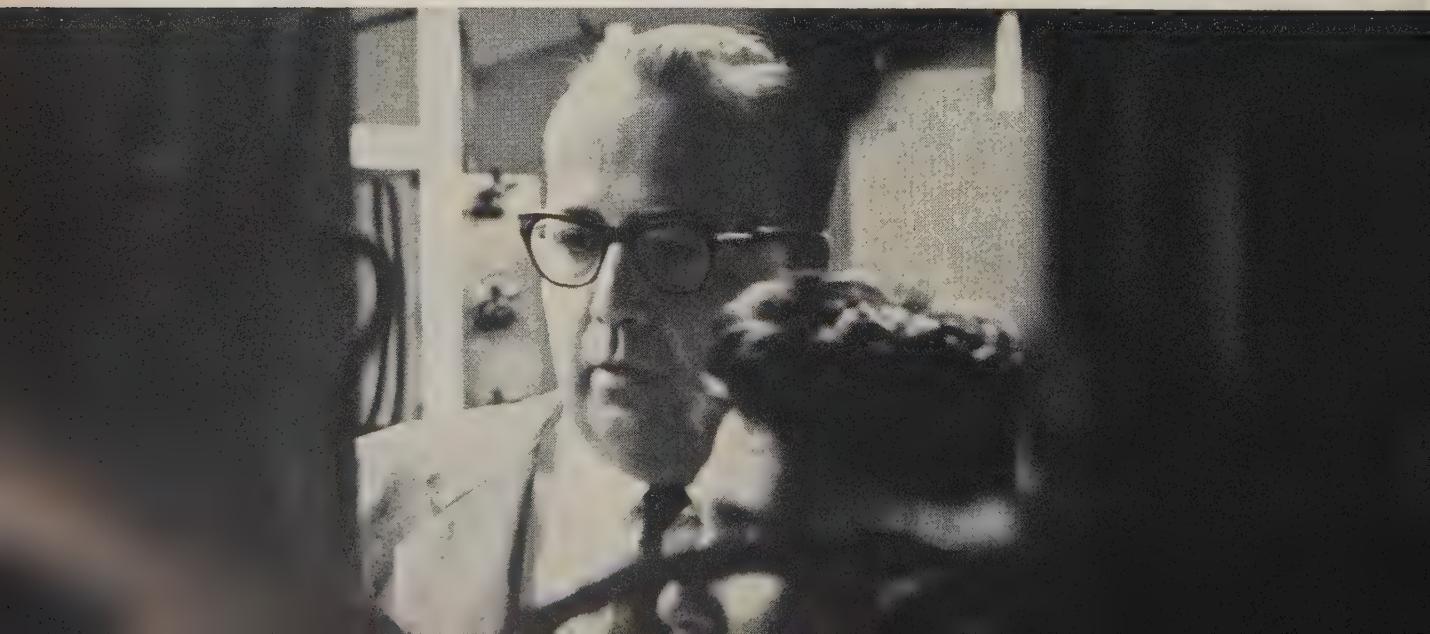
Arthur Reese, Vice President and General Manager  
Communications Division



Three field commanders direct day-to-day activities of Motorola's technical divisions. Wheeler's Military Electronics Division concentrates directly on military problems, drawing on the resources of Reese's Communications Division (world's largest producer of two-way communication systems) and Hogan's Semiconductor Division (world's largest producer of power transistors and leader in mesa transistor development and production). Behind this technical task force stands Motorola's strength in consumer electronics; in an emergency the company's total complex of 18 plants in four states can be converted to mass production of military equipment.



Dr. Lester Hogan, Manager  
Semiconductor Products Division



*Of Motorola's 2,000 engineers and scientists, four out of five work under the direction of Dr. Daniel E. Noble, Executive Vice President. One of the three divisions under his command is devoted exclusively to military electronics; two others provide strong support. Working together, they form a*

# MOBILE TECHNICAL TASK FORCE

Officials of the Air Force Flight Test Center at Edwards faced a particularly knotty problem. Specialized microwave equipment was required to relay telemetry from aircraft in remote areas.

At the request of the military, Motorola rapidly assembled the talent and equipment of its tri-divisional technical task force. Heaviest contributions to the project were made by Motorola's Military Electronics Division. But important help came from other sources: microwave equipment and vhf receivers from Motorola's Communications Division; specialized transistor circuitry from the Semiconductor Products Division.

With this swift concentration of technical talent drawn from a diversity of company sources, Motorola was able to solve a major problem for the Air Force in record time.

Few organizations serving the military today can so rapidly merge diverse technical talents and productive capacities as can Motorola. Its three "task force" divisions, under the single command of Dr. Daniel Noble, can be marshalled almost overnight for the solution of urgent military electronics problems. Cross-fertilization of ideas and techniques is the certain result.

The success of this flexible organizational structure was again demonstrated by Motorola's part in the development of the Project Mercury Space Capsule. The Capsule's command control receiver, developed

by Motorola's Military Electronics Division, is the smallest all-transistorized radio receiver of its type available, thanks to mesa transistors developed by the Semiconductor Division and miniaturization techniques borrowed from packaging specialists of the Communications Division. In another instance, Motorola's Semiconductor Division developed the first samples of a new type of electronic facsimile paper with important military applications.

In an era marked by a chronic shortage of competent brain-power, Motorola's strategic deployment of its technical resources is an effective answer, both in the solution of current problems and in conducting long-range research.

Strategic deployment of manpower is only one of the reasons why Motorola is able to design, develop and produce military systems and equipment with speed, economy and reliability. Motorola's exclusive concentration in electronics, its cost-conscious approach to producibility, and its preoccupation with reliability, are evident in every Motorola military product, from the smallest solid state device to the most complex weapons systems.

For a comprehensive brochure on Motorola's Military Electronics capabilities, write: *Technical Data Service, Motorola, Inc., Military Electronics Division, 8201 East McDowell Road, Scottsdale, Arizona.*



**MOTOROLA**

**Military Electronics Division** / CHICAGO • PHOENIX • RIVERSIDE

*Engineers and Physicists interested in career opportunities are invited to write: Motorola, Inc., Military Electronics Division*



1450 NORTH CICERO AVENUE  
CHICAGO 51, ILLINOIS



8201 EAST McDOWELL ROAD  
SCOTTSDALE, ARIZONA



B330 INDIANA AVENUE  
RIVERSIDE, CALIFORNIA





## He is looking at the conquest of space

The man above is studying the vibration reaction of a Union 6 PDT miniature relay, at the reliability laboratory of Convair-Astronautics, San Diego, Calif.

**Result:** These Union Switch & Signal relays were chosen by Convair for the guidance of their Atlas missile, launched into orbit December 18, 1958.

Extreme reliability was needed in the Atlas guidance system, to insure precise control of flight. And the Union relay subjected to thorough testing, answered that need.

Part of the 6 PDT relay reliability can be laid to its small size and its clean, simple, rotary design which gives it fewer inherent problems than other relays. In tests at Union Switch & Signal, it has proved its ability to give outstanding performance in critical dry-circuit control applications—was absolutely solid to 2,000 C.P.S. at 15G!

The relay used in the Atlas is just one of a complete line of dependable relays designed by Union Switch & Signal. Write today for complete technical details.

*"Pioneers in Push-Button Science"*



**UNION SWITCH & SIGNAL**  
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

Write in No. 47 on Reader Service Card at start of Product Preview Section

## CAPABILITIES

services such as studies of blast and heat effects by model and by analytical methods. Design, development and production of launcher erector, gas charging, and coolant charging equipment. Engineering and prototype production in the hydraulic, pneumatic and structural fields as well as electronic packaging. Emphasis on special valve development.

- **GSE CONTRACTS**—Convair electrical and electronic checkout equipment for Atlas; Bomarc prototype launching equipment design.

- **GSE LITERATURE** — Ground Equipment Brochure (No. 635 on Card).

**THE ANNIN CO.**, Box 22081, Los Angeles, Calif.

- **GSE SPECIALTIES**—design and development of valves for rocket and missile ground installations for pressures to 10,000 psi and temperatures from -400°F to 600°F.

- **GSE CONTRACTS**—Douglas control valves for missile and rocket GSE development; Martin: control valves for missile and rocket GSE development; Hicks & Ingle: control valves for missile and rocket GSE development.

- **GSE LITERATURE** — General Catalog (No. 636 on Card); Actuator Bulletin (No. 637 on Card); Small Flow Control Valve Bulletin (No. 638 on Card); "Wee Willi" Domotor Valve (No. 639 on Card).

**APPLIED RESEARCH LABORATORIES, INC.**, Box 1710, Glendale 5, Calif.

- **GSE SPECIALTIES** — electronic-optical-mechanical assemblies and test equipment for missile checkout.

- **GSE LITERATURE** — Manufacturing Capabilities in Electronic, Mechanical and/or Optical Assemblies (No. 640 on Card).

**THE ARO EQUIPMENT CORP.**, Bryan, Ohio

- **GSE SPECIALTIES**—test stands and special tools for liquid oxygen converters and specialized cryogenic equipment. Liquefied gas storage tanks ranging in size from 5 to 500 liters capacity.

- **GSE CONTRACTS**—liquid oxygen converter system purgers and testers for Republic, Convair and Boeing.

- **GSE LITERATURE**—Facility and GSE Projects Brochure (No. 641 on Card).

**AUTOMATIC SWITCH CO.**, 50-56 Hanover Rd., Florham Park, N.J.

- **GSE SPECIALTIES**—Valves for handling oxygen, hydrogen, helium and nitrogen at pressures to 3000 p.s.i. and temperatures to minus 350°F. Two, three and four way valves with standard, explosion-proof or watertight solenoids are supplied in sizes from  $\frac{3}{8}$ " through  $2\frac{1}{2}$ ".

- **GSE CONTRACTS**—Subcontracts for Lockheed, Convair, Rocketdyne, Martin and others (valves used in Atlas, Titan and Polaris GSE).

- **GSE LITERATURE**—ASCO Solenoid Valves for Missiles (No. 642 on Card); ASCO Solenoid Valves Engineered to Missile Ground Support Requirements (No. 643 on Card).

**AUTONETICS DIV., NORTH AMERICAN AVIATION, INC.**, 9150 E. Imperial Highway, Downey, Calif.

- **GSE SPECIALTIES** — Automatic checkout equipment.

• GSE CONTRACTS—R & D and production: checkout system for A3J above and below deck (aircraft carrier use; USAF classified (two contracts).

• GSE LITERATURE—Autonetics Checkout Centrals (No. 644 on Card); Technical Description of Autocheckout Equipment (No. 645 on Card); Description of Autonetics Model C6A (No. 646 on Card).

**AVIEN, INC.**, 58-15 Northern Blvd., Woodside 77, N.Y.

• GSE SPECIALTIES—automatic checkout equipment for primary measurements of liquid mass flow, temperatures (gases, liquids or solids), and voltages and frequencies to high accuracy and within preset tolerance bands). Also automatic selection of highest or lowest parameter in a group of similar parameters (continuously not sequentially) for recording and display.

• GSE CONTRACTS—Hound Dog limit detector used as go-no-go checkout for ground and airborne monitoring; Atlas launcher hydraulic oil level monitor A3J oxidizer maximum temperature indicator.

• GSE LITERATURE—Multi Channel Temperature Analyzer (No. 647 on Card); Signal Comparator (No. 648 on Card); Maximizing—Minimizing Bridge (No. 649 on Card); Self-Balancing Potentiometer (No. 650 on Card); Jet Engine Time-Temperature Recorder (No. 651 on Card).

**BALDWIN-LIMA-HAMILTON CORP., ELECTRONICS & INSTRUMENTATION DIV.**, 42 Fourth Ave., Waltham 54, Mass.

• GSE Specialties—design, manufacture and installation of precision force and weight measuring systems, particularly as related to missile weight, thrust and CG determination. Installation of complete launching and test facilities (such as those for Vanguard and Titan), rocket engine test stands for precise measurement of weight, thrust, pitch, roll, side forces, etc. Electronic measuring systems (using load cells) to provide accurate determination of force and thrust ranging from a few pounds to several millions of pounds.

• GSE CONTRACTS — Martin: multicomponent thrust measuring system for both static testing and prelaunching checkout for Titan; Aerojet-General: design and manufacture of multicomponent rocket engine thrust stand and measuring systems for first and second stage Polaris missile; Redstone: design, manufacture and installation of multicomponent stand and measuring system.

• GSE LITERATURE—B-L-H Special Products (No. 652 on Card).

**BARBER-COLMAN CO.**, Rockford, Ill.  
• GSE SPECIALTIES—Temperature control and positioning systems including control boxes, air valves, electro-mechanical actuators, temperature sensing elements and thermostats.

• GSE CONTRACTS—Thor: temperature control system for ground conditioning of guidance measurement compartment; Convair F-106: temperature control system in the air conditioning ground supply cart.

• GSE LITERATURE—Bulletin F-5910 (No. 653 on Card).

more on next page



## New UNION readout instruments withstand shock, vibration and extreme temperature changes

Union Switch & Signal's new READALL\* readout instrument replaces complicated systems of lights and relays for reading, storing or transferring all types of information for industrial and military applications. It is not to be confused with conventional indicating devices.

**Designed to meet requirements of MIL-E-5422D.** The new READALL readout instrument is precision-built and provides instantaneous and continuous operation under conditions of shock, vibration and extreme ranges in temperature. The digital display includes characters in numerical sequence from 0 to 9 plus two blank spaces.  $\frac{7}{32}$ -inch characters can be illuminated red or white as desired; when not illuminated, they appear white against a black background.

**Reliability.** Performance through one million random operations is an inherent feature of the new READALL instrument. Each module is gasket-sealed in its case to exclude moisture and seal out foreign particles. An especially thin enclosed DC motor, containing ball bearings, permits more efficient operation.

**Modular Construction.** A unique feature of the readout instrument is its modular construction. It can be used individually or in groups to display multiple characters in a single case.

**Direct Code Translation.** The operation of the READALL readout instrument is based on a positioning system using a four-bit code. The visual display is the result of a direct electro-mechanical conversion of a binary signal to a decimal read-out. There is no need for additional conversion equipment. Separate code and motor circuits permit the use of the readout instrument in low-level circuitry.

**Electrical and Visual Data Storage.** Once positioned, the information is displayed until a new code is transmitted to the instrument. No power is consumed while the information is retained. This data may be stored or read-out electrically for further transmission or recording.

**Operate Time.** The operate time varies from 0.1 second to 1.0 second depending on character position.

**Weight and Size.** Maximum weight including case is seven ounces; without case, four and one-half ounces. Size encased is  $5\frac{1}{8}\frac{1}{4}$  inches long,  $1\frac{7}{16}$  inches high and  $3\frac{3}{8}\frac{1}{4}$  inch wide. The new READALL instrument is designed for operation over a temperature range of  $-54^{\circ}\text{C}$  to  $+71^{\circ}\text{C}$  in humidities up to 100% and altitudes up to 70,000 feet. For more information, write for Bulletin 1019.

\*Trademark

*"Pioneers in Push-Button Science"*



**UNION SWITCH & SIGNAL**

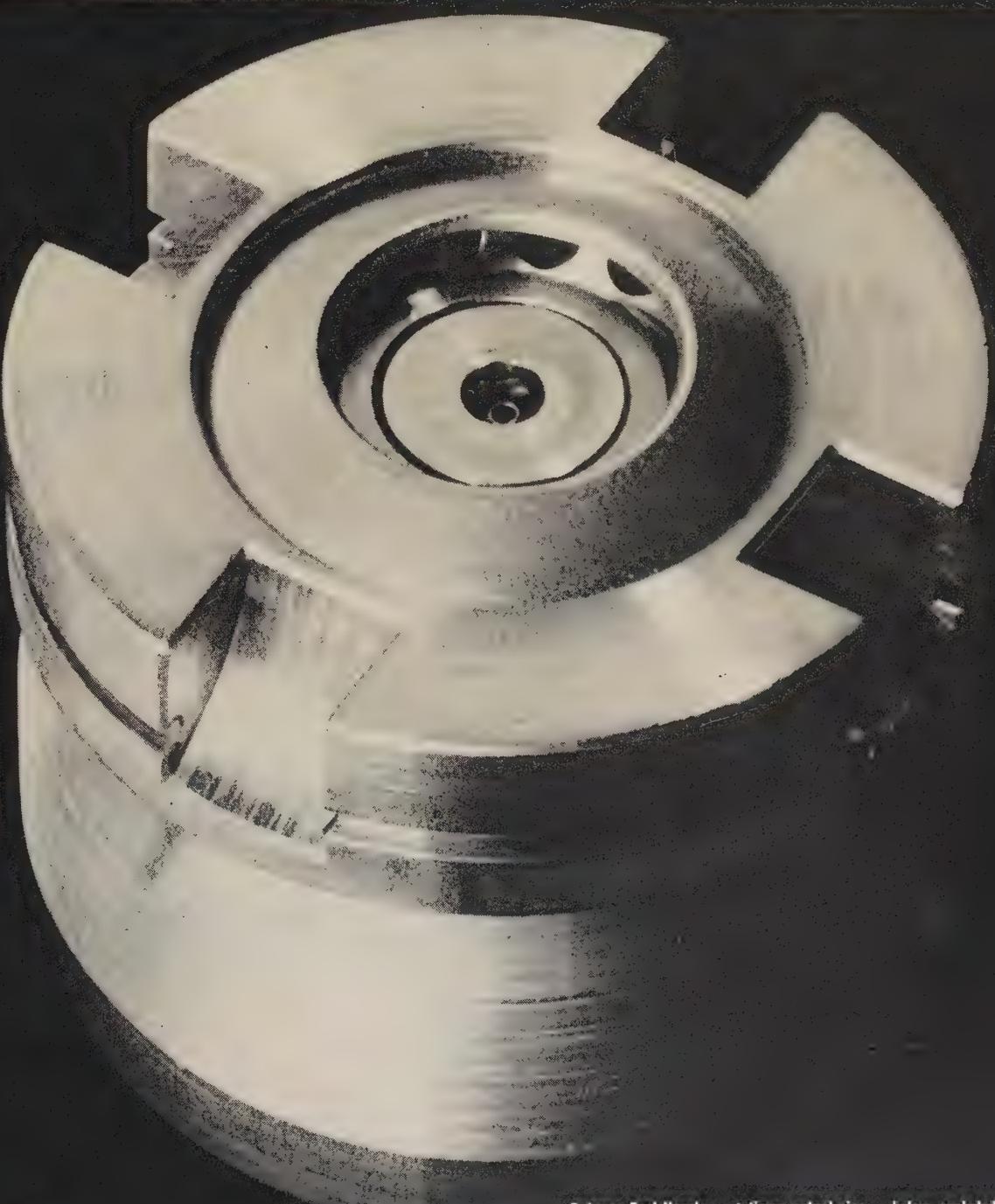
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY —

PITTSBURGH 18, PENNSYLVANIA

Write in No. 48 on Reader Service Card at start of Product Preview Section



ITEM: Delavan Manufacturing Company has produced 1,000,000 fuel nozzles for Pratt & Whitney Aircraft's J-57 turbo-jet engine. The millionth nozzle passed Delavan's performance tests and was shipped to Pratt & Whitney on August 11, 1959. The achievement seemed worthy of announcement. You don't turn out a million something everyday, especially if that something is as complex and precise as a fuel nozzle. They are very important components in a turbo-jet engine; they've got to be very, very accurate.

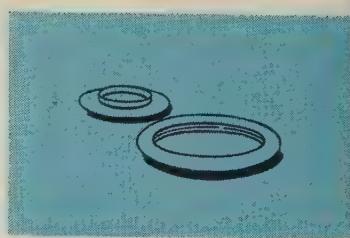


Delavan Fuel Nozzle — 6 times actual size — below, exploded view, actual size.





**Garlock's unique position in the missiles**

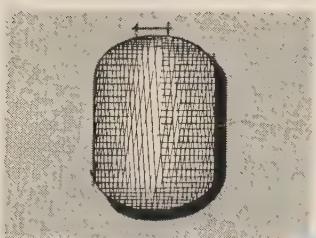


**GARLOCK METAL FITTINGS  
FOR ROCKET MOTOR CASES**  
such as blast tube and thrust terminator support rings are machined to extremely close tolerances. Made from special materials affording minimum weight, maximum strength and rigidity.

## industry . . .

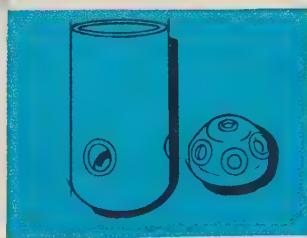
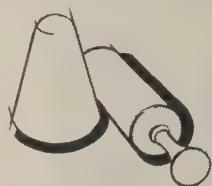
**GARLOCK'S UNIQUE POSITION** in the missiles industry may be of infinite value to you.

**ACCEPTANCE:** Right now Garlock is supplying rocket motor components for various phases of development and production of seven different missiles. **FLEXIBILITY:** Garlock has the people, the equipment, and the experience to swing into prototype production on short notice, and to follow this with full-scale production as needed. **DIVERSIFIED ABILITIES:** Garlock is thoroughly familiar with the design and manufacture of components from a wide range of basic materials—metals, rubber, phenolics, fluorocarbons and other plastics. **COMPLETELY INTEGRATED STAFF:** Garlock's product design, tool design, pilot manufacturing and production staffs are completely integrated for efficient handling of a project from start to finish. Garlock engineers will work to your design—or with you in developing designs. Write or call Military Products, The Garlock Packing Company, Palmyra, New York. **GARLOCK**



**FILAMENT WOUND ROCKET MOTOR CASES** made by exclusive Garlock method results in structure much lighter and stronger than steel.

**MISSILE PARTS FROM INERT MATERIALS** include newly developed asbestos-phenolic compound for nozzles . . . nose cones of fluorocarbon plastics.



**INSULATION FOR SOLID FUEL ROCKET MOTORS** made by Garlock is rubber-like compound which encounters gas velocities of Mach 3, temperatures to 5500°F, prolonged ambient temperatures of 300°F.

**Garlock components are presently used in the development and production of:**

Vanguard      Minuteman      Super Tartar      Polaris  
Super Vanguard      Nike Hercules      Terrier

Write in No. 81 on Reader Service Card at Start of Product Preview Section

## CAPABILITIES

# HOW DOES YOUR PRESENT FASTENING SYSTEM MEASURE UP TO THE VERSATILE **HUCKBOLT?**\*

- **LOW INSTALLED COST**
- **POSITIVE MECHANICAL LOCK**
- **EXCELLENT PULL-TOGETHER**
- **UNSKILLED, ONE-MAN APPLICATION**
- **UNIFORM CLINCH**
- **BROAD GRIP TOLERANCE**
- **EASY REMOVAL**
- **HIGH SHEAR & TENSILE STRENGTH**
- **NO LOOSENING OR STRIPPING**
- **BROAD BEARING**
- **NO LOOSENING BY OVERDRIVING**

Huckbolt fasteners have effected savings of as much as 70% over previously used fastening methods.

These versatile, efficient fasteners are available in diameters, grips, headstyles and metals to suit your needs.

Lightweight, sturdy, easy-operating Huck power or hand tools install these fasteners with absolute uniformity at rates up to 30 per minute by one unskilled operator. Let Huck's experienced fastener engineers help you with your fastening problem.

- 1 TENSION TYPE FASTENER
- 2 FEATHERWEIGHT TYPE FASTENER
- 3 BROAD GRIP TOLERANCE FASTENER
- 4 BROAD BEARING FASTENER

\*T.M. of Huck Manufacturing Company

# HUCK

MANUFACTURING COMPANY

2480 BELLEVUE AVENUE • DETROIT 7, MICHIGAN • Phone WALnut 3-4500

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- **GSE CONTRACTS** — Sylvania Electronics Data Processing Div: fully transistorized computer power supply, using 208 volts  $\pm 20\%$ , 3 phase, 60 cycle input, for multi-purpose mobile digital computer, RCA complete electronic load center system for BMEWS sites.

- **GSE LITERATURE**—Bogus Missile Systems and Ground Support Equipment (No. 665 on Card); Bogue High Voltage Power Supplies (No. 666 on Card); Bogue Silicon Junction Rectifiers (No. 667 on Card); Bogue NPN Grown Junction Silicon Transistors (No. 668 on Card); Bogue 400 Cycle Power (No. 669 on Card); Ultrasonic Gaging of Cryogenic Liquids (No. 670 on Card); Bogue Sonic Liquid Level Indicators (No. 671 on Card); Bogue Trans-Tork Fully Automatic Speed Control Bulletin (No. 672 on Card); Bogue Trailer Mounted Electric Power Supply (No. 673 on Card); Bogue Automatic Battery Chargers (No. 674 on Card).

**BURROUGHS CORP.**, 6071 Second Ave., Detroit 32, Mich.

- **GSE SPECIALTIES** — missile checkout equipment, terminal equipment, recording devices for data processors and computers.

- **GSE CONTRACTS**—MOD III Atlas ICBM ground computer terminal equipment and recording devices; message storage device for 433L Weather Forecasting and Observation System; teletypewriter for 433L.

- **GSE LITERATURE** — Electrographic Recording Technique (No. 675 on Card); Burroughs SAGE (No. 676 on Card); Weapons Systems (No. 677 on Card); Weapons System Management (No. 678 on Card); Military Electronic Computer Division Facility Report (No. 679 on Card); Military Products and Systems (No. 680 on Card); Electrostatic Recording (No. 681 on Card); Radar Data Processing for SAGE (No. 682 on Card).

**CALIFORNIA TECHNICAL INDUSTRIES DIV., TEXTRON INC.**, 1421 Old County Rd., Belmont, Cal.

- **GSE SPECIALTIES** — manufacture automatic test equipment, such as the Model 180 tape-programmed super-tester and 165 cable-harness analyzer for ground support, pre-flight, and maintenance testing. Also special automatic testing systems for electronic equipment to customers' specifications.

- **GSE LITERATURE**—1959 Short-Form Catalog (No. 683 on Card).

**CALLERY CHEMICAL CO.**, 9600 Perry Highway, Pittsburgh 37, Pa.

- **GSE SPECIALTIES** aircraft component and system testing with high-energy fuels; design of ground handling facilities for high-energy fuels.

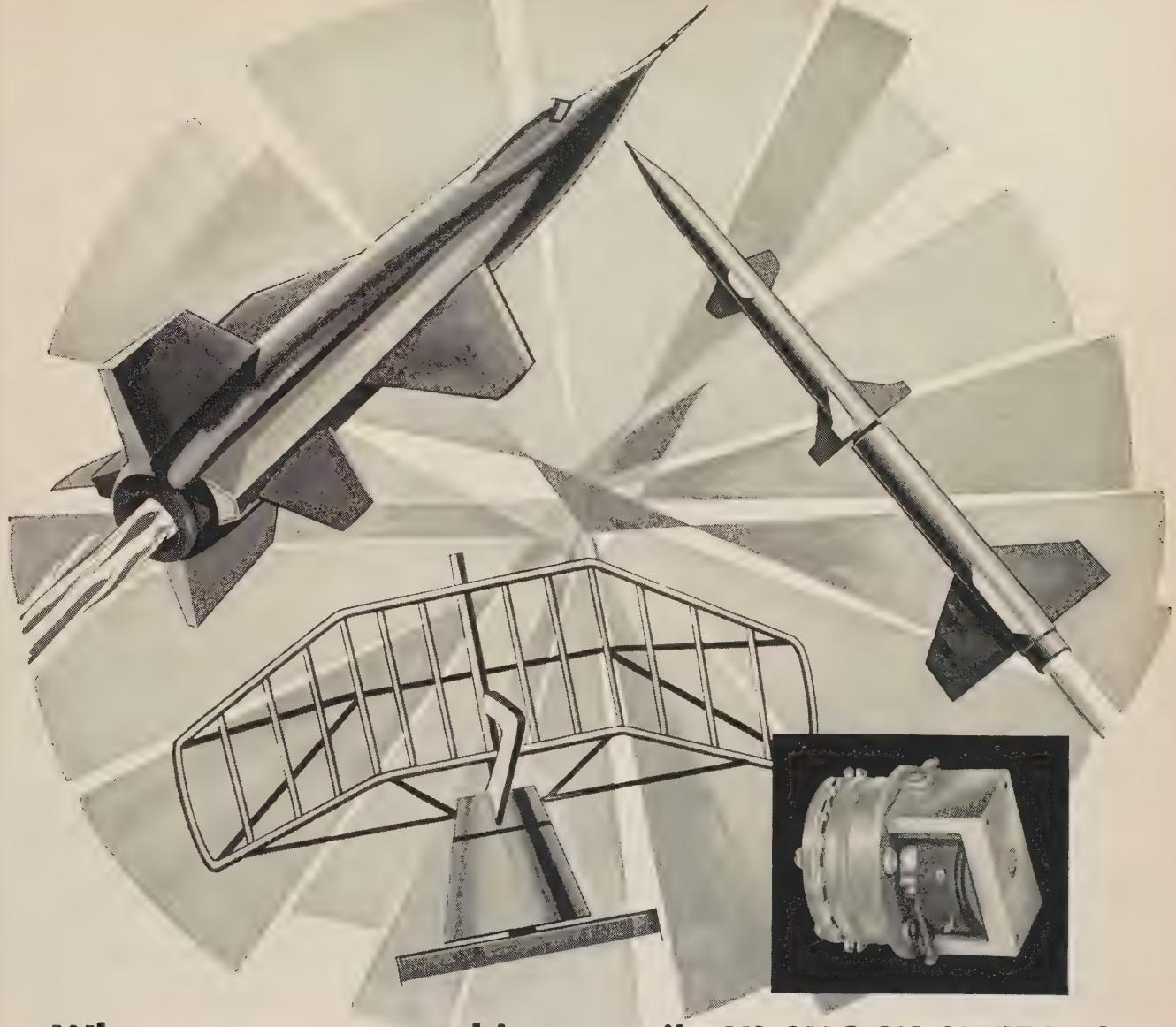
**CANNON ELECTRIC CO.**, 3208 Humboldt St., Los Angeles 31, Cal.

- **GSE SPECIALTIES** — missile and aircraft umbilical plugs used to carry a large number of circuits from ground power, control, and checkout equipment to the missile or aircraft. Also custom-designed plug/harness assemblies.

- **GSE CONTRACTS** — umbilical plugs for Nike, Talos, Vanguard, Jupiter, Thor, Atlas and Titan missile GSE.

**more on page 110**

SPACE/AERONAUTICS



## Where can you use this versatile HI-SHOCK SWITCH?

**Military;** missiles, mines, shipboard antennas, or industrial and commercial equipment wherever rigorous vibration, shock or constant acceleration is present, this new Hi-Shock Switch offers distinct advantages.

**Engineered and custom-packaged.** The Hi-Shock Switch can be used for remote power switching (mounted directly on moving members)...changeover from primary to auxiliary power source, AC or DC...rapid stepping of power distribution.

**Hermetically Sealed.** Use in remotely controlled, power operated units or as a sequence exciter for auxiliary prime movers.

**100% Rotary Action, Counter Balanced.** The actuator, a rotary solenoid, is

counter balanced in all axes. Standard coil voltages range from 6 to 48 volts, but other ranges can be furnished as required. High-speed stepping—30 per second—is one feature; higher speeds are available for specific designs.

**Positive Stopping, Positive Locking.** The ratchet mechanism prevents overshooting of the switch contacts—which will not move except during actual stepping. This mechanism is simple, reliable, virtually fatigue-proof.

**Knife-Edge Contacts.** On rotary switch contacts are strong and simple, provide positive connections to prevent chattering under acceleration and other vibration-producing conditions.

**Environmental Ratings.** The Hi-Shock Switch withstands non-operating im-

pacts of 1000 g for one millisecond parallel to its rotating axis, and 100 g for one millisecond perpendicular to its rotating axis. The stepping switch operates under vibration, in three mutually perpendicular axis, of 0.5" double amplitude 5–17.5 cps., and 10 g 17.5–2000 cps. Constant operating acceleration may be as high as 100 g, in axis parallel to rotation. Operating temperature range may exceed -65°F. and +165°F., and could be extended under special conditions.

Other models also developed with varying configurations and contact arrangements with higher current rating. Write for complete details. *Hi-Shock, Singer Military Products Division, Singer-Bridgeport, 915 Pembroke Street, Bridgeport 8, Conn.*



**SINGER-BRIDGEPORT**

A DIVISION OF THE SINGER MANUFACTURING COMPANY

915 Pembroke Street

Bridgeport 8, Conn.

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## CAPABILITIES

Special waterproof bulkhead plug for Polaris submarines.

- GSE LITERATURE — Guided Missile Umbilical Plugs (No. 684 on Card); Cannon Plug Systems and Facilities (No. 685 on Card); Missile Plug for Manned Aircraft (No. 686 on Card).

**CHICAGO PNEUMATIC TOOL CO.,** 6 E. 44th St., New York 17, N.Y.

- GSE SPECIALTIES — "custom" linear and rotary type actuators and power units for missile launching systems; "custom" motors for accessory components such as air conditioning systems and blowers; complete package type Diesel engines supplying prime power for missile launching and ground facilities; stationary compressors for air liquefaction for missile application.

- GSE LITERATURE — Motors (No. 687 on Card); Actuators (No. 688 on Card); Diesel Engines (No. 689 on Card); Air Compressors No. 690 on Card).

**CHRISTIE ELECTRIC CORP.**, 3410 W. 67th St., Los Angeles 43, Cal.

- GSE SPECIALTIES — low voltage, high current, direct current power supplies for use in ground checkout, go-no-go test equipment. Also specialized in the design and manufacture of automatic battery charging equipment for GSE lead-acid, nickel-cadmium, and silver cell batteries.

- GSE CONTRACTS — test power supplies for BuShips on Talos and Polaris; ITT Federal: power supply units, from 5-500 amperes, for go-no-go checkout of Boeing Bomarc IM-99; Sandia: power supplies for testing missile atomic warheads; Convair-Astronautics dc power supplies for Atlas.

- GSE LITERATURE — Silicon Power Rectifiers (No. 691 on Card); Silicon Battery Chargers (No. 692 on Card); Missile Testing Power Supply Spec Sheets (No. 693 on Card); Silicone Filament Heater Power Supply Spec Sheet (No. 694 on Card); Automatic Battery Tester & Charger Spec Sheet (No. 695 on Card).

**COLES CRANES, INC.**, Box 942, Joliet, Ill.

- GSE SPECIALTIES — gasoline and diesel-electric powered cranes for smooth and precise missile handling. Remote controls so that missile site operator can actuate crane up to 100 yards away.

- GSE CONTRACTS — American Machine and Foundry: joint development of a remote control crane for handling Titan first stage; crane for Bomarc missile.

- GSE LITERATURE — Coles Gasoline or Diesel-Electric Transmission (No. 696 on Card); Typical Large Strut Boom Crane Superstructure (No. 697 on Card); Operator Cab (No. 698 on Card); Reversing Steering Mechanism (No. 699 on Card); Safe Load Indicator (No. 700 on Card); Limit Switches (No. 701 on Card).

**COMPUDYNE CORP.**, 400 S. Warminster Rd., Hatboro, Pa.

- GSE SPECIALTIES — design and manufacture of control systems for flight test facilities. These systems generally incorporate on-line computer controllers and electro-hydraulic final positioning

more on page 113

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Write in No. 85 on Reader Service Card →  
SPACE/AERONAUTICS



8423-SR

## ... specify STALWART!

MOLDED

EXTRUDED

SPLICED

DIE CUT

MACHINE CUT

HAND CUT

PRECISION GROUND

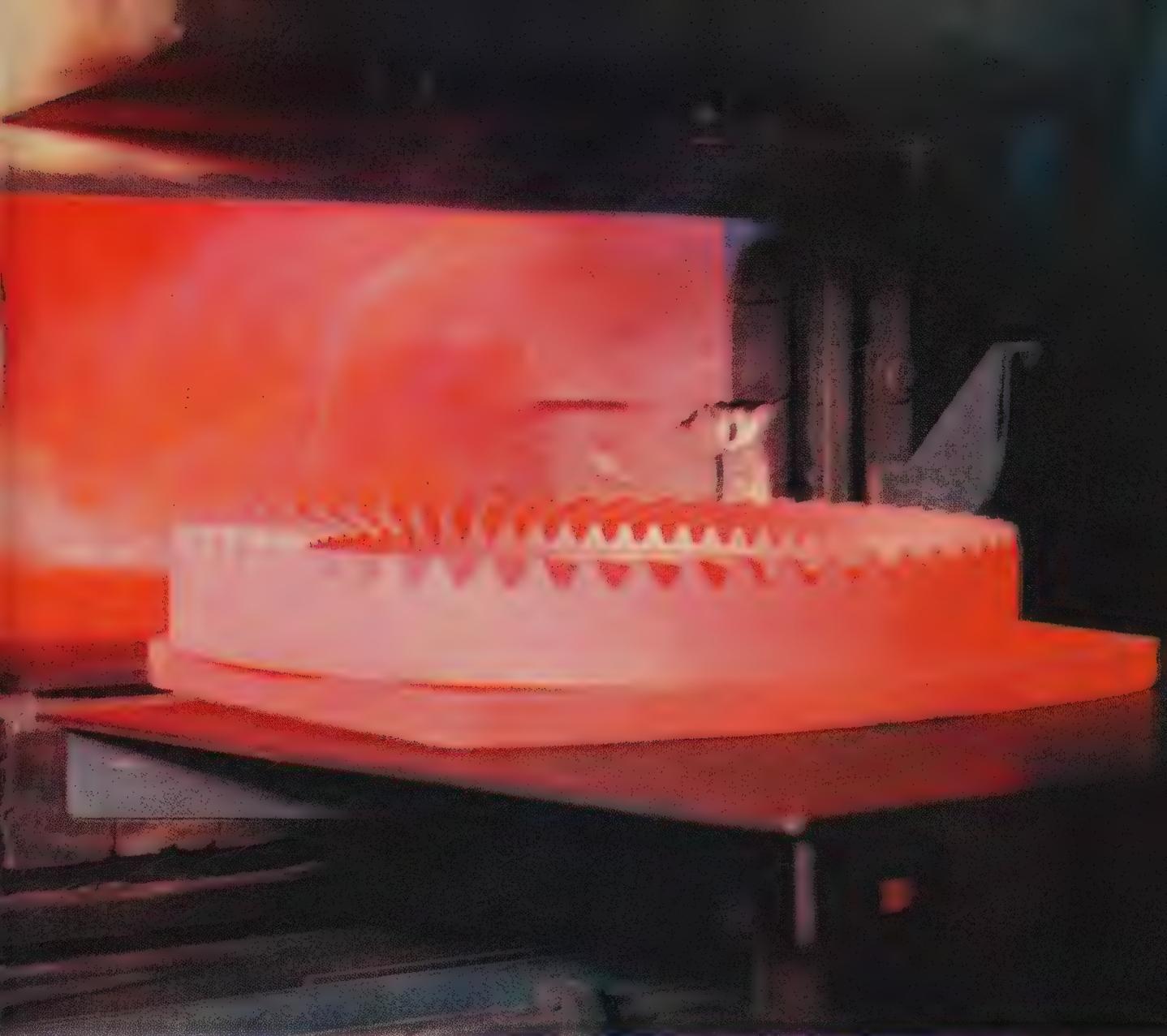
Write today for complete information.  
Ask for your copy of Stalwart Catalog SR-59.



363 Northfield Road • Bedford, Ohio  
Manufacturing facilities in  
Jasper, Georgia and Bedford, Ohio

**STALWART**  
RUBBER COMPANY

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This large concave spiral bevel gear is so distortion free after heat treatment that it meets the highest aircraft gearing standards without subsequent tooth grinding.

## Precision is our only product!

In the rapidly changing field of aeronautical technology, the word "precision" becomes more and more common in use. At Indiana Gear, however, precision has always been more than a word. It is a way of thinking . . . a method of working always beyond the fringe of the state of the art.

**IGW**  
INDIANA GEAR WORKS, INC.  
INDIANAPOLIS, INDIANA

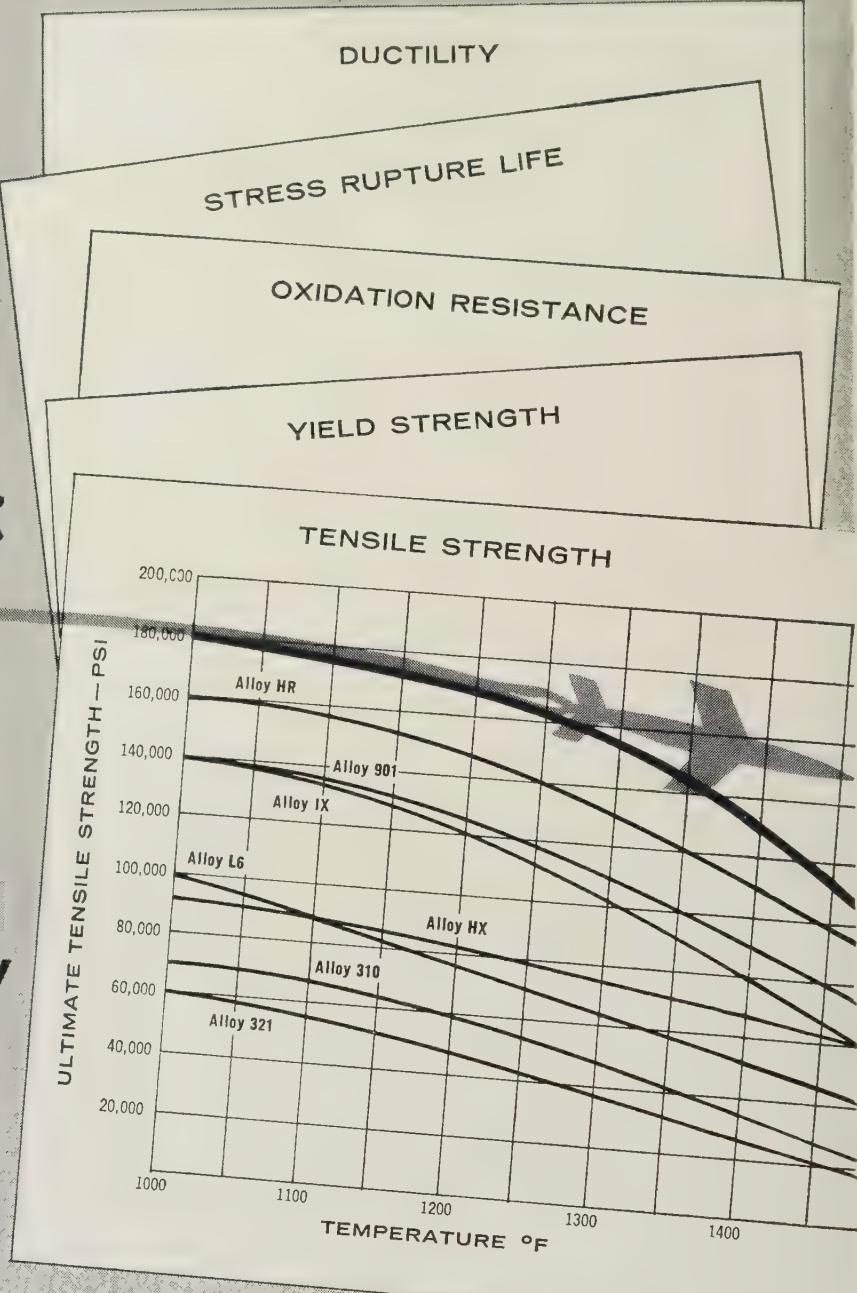
Indianapolis, Ind., ME 8-2331, TWX IP-174-U • Redondo Beach, Cal., FR 5-7597, TWX 7856-U • Westport, Conn., CA 7-0262, TWX 486-U



**HIGH**  
on every  
chart:

**RENÉ 41\***

most  
dependable alloy  
in use today  
in the  
**1200°-1800°F**  
range



In all ways, René 41 is a remarkable alloy. No other high-temperature alloy used in production today equals its tensile strength. In other properties, too, René 41 is far ahead of the field.

Also important, this nickel-base, vacuum-melted alloy is easy to work with. It's readily formable by drawing, bending, spinning — welds to similar or dissimilar materials.

Cannon-Muskegon offers René 41 in standard 36"x 96" sheets .015" to .125" thick, in smaller sizes down to .010", in bar stock up to 3" in diameter ...

foil down to .001 in thickness ... and fine wire only .0015 in diameter.

For complete details, write for Technical bulletin No. 86.

\*TM of General Electric Co.



**CANNON-MUSKEGON CORPORATION**

2887 Lincoln Avenue • Muskegon, Michigan

METALLURGICAL SPECIALISTS  
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SPACE/AERONAUTICS

## CAPABILITIES

elements. Included are rocket fuel flow, ratio and pressure control systems, and missile and rocket accessory test facilities. Also complete engineering and contracting of instrumentation and controls for missile launching sites.

• GSE CONTRACTS — Bell: complete pressure and ratio control system for field testing rocket combustion chamber; Winger Construction: complete instrumentation and control for fuel loading of missile at launching sites.

**CONSOLIDATED AIRBORNE SYSTEMS, INC.**, 72 E. Second St., Mineola, N.Y.

• GSE SPECIALTIES—Design and production of electronic and electro-mechanical GSE. Includes automatic checkout equipment for aircraft; automatic pre-launch equipment for missiles; test equipment for aircraft and missile sub-systems; liquid level measurement systems; fuel management temperature indicating RPM systems; field test equipment to check out instrumentation units such as RPM indicators, liquid oxygen indicators, fuel gage indicators and temperature indicators.

• GSE CONTRACTS—Liquid oxygen tester; fuel gage tester; tachometer system tester.

• GSE LITERATURE — Liquid Quantity System Tester (No. 703 on Card); Tachometer System Tester (No. 704 on Card).

**CONSOLIDATED DIESEL ELECTRIC CORP.**, 880 Canal St., Stamford, Conn.

• GSE SPECIALTIES — multi-purpose ground power equipment for jet and piston aircraft and missiles (electrical, pneumatic and hydraulic power for starting, servicing and testing); air conditioning; special handling and maintenance equipment; ground moving equipment; bio-medical instrumentation systems; runway sweepers; passenger loading stands; hydraulic, pneumatic, fuel, electrical and mechanical stands for systems and component functional testing; diesel and gasoline engine-driven ground power equipment for emergency standby and normal use; precise power generating equipment; uninterrupted power supplies; automatic electronic test equipment; digital data reduction systems; and transistorized electronic power supplies.

• GSE CONTRACTS—AF: MD-3 self-propelled aircraft electrical ground support trailers; MJ-2A portable hydraulic test stands to be used with Century-series aircraft; MC-1 runway vacuum sweepers; Lockheed Missile Systems: mobile bio-medical complex consisting of laboratories, data reduction system, power unit, altitude chamber and workshop.

• GSE LITERATURE — Corporate Facilities (No. 705 on Card); MA-1 Self-Propelled Multi-Purpose Ground Support Unit (No. 706 on Card); MA-2 Self-Propelled Multi-Purpose Ground Support Unit (No. 707 on Card); MD-3 Self-Propelled Aircraft Electrical Ground Support Trailer (No. 708 on Card); NC-5B Self-Propelled Multi-Purpose Ground Support Unit (No. 709 on Card); Trailer Mounted Aircraft Support Generator Sets (No. 710 on Card); Self-Propelled Multi-Purpose Ground Support Unit (No. 711 on Card); Self-Propelled Continuous Air Source Jet Engine Start Unit (No. 712 on Card); Self-Propelled

Universal Passenger Loading Stand (No. 713 on Card); Self-Propelled Mobile Electric Power Plant (No. 714 on Card); Engine Generator Set (No. 715 on Card); Skid Mounted Gasoline Engine Driven Generator Set (No. 716 on Card); Trailer Mounted Generator Set (No. 717 on Card); Self-Propelled Mobile Electric Power Plant (No. 718 on Card).

**CONSOLIDATED SYSTEMS CORP.**, 1500 S. Shamrock Ave., Monrovia, Calif.

• GSE SPECIALTIES—dynamic checkout units, ullage simulation assembly and propellant utilization exerciser systems for dynamic preflight checkout of missiles; sequencers for automatic programming; static checkout systems to insure tactical readiness of missiles; automatic data recording and monitoring systems.

• GSE CONTRACTS—RCA: propellant utilization system exercisers for Atlas; Convair Astronautics: high-pressure helium and nitrogen control systems for dynamic checkout of Atlas pneumatic and fuel systems.

• GSE LITERATURE—Rocket and Jet Engine Test (No. 729 on Card); Telemetry Ground Stations (No. 730 on Card); Rocket Fuel Control (No. 731 on Card); Missile Ground Support Equipment (No. 732 on Card); Pressure With Precision (No. 733 on Card); Development Capabilities Brochure (No. 734 on Card).

**THE CORNELIUS CO.**, 550-39th Ave. N.E., Minneapolis 21, Minn.

• GSE SPECIALTIES—design and manufacture of lightweight, hand and air portable air compressors for aircraft and missiles in accordance with USAF MIL-C-25689 and MIL-C-26519.

• GSE CONTRACTS — Boeing: ground support air compressor for KC-135.

• GSE LITERATURE—Air Portable Shop-Type Air Compressor and Pneumatic System (No. 735 on Card); Air Portable Ground Support Air Compressor and Pneumatic System (No. 736 on Card); Air Portable High Pressure Air Compressor (No. 737 on Card); High Pressure Air Compressor (No. 738 on Card); Portable High Pressure Air Compressors (No. 739 on Card).

**CORNING GLASS WORKS**, Corning, N.Y.

• GSE SPECIALTIES—special protective glass such as high density high lead content glass for non-darkening radiation shielding windows. Heat shield glass coated with a thin, transparent electrically-conductive film that transmits 65 per cent of long wave infrared. Also optically engineered glass lenses for exterior and interior illumination.

• GSE LITERATURE—Radiation Shielding Windows (No. 740 on Card); Pyrex Heat Shield (No. 741 on Card); Commercial Lighting Application Guide (No. 742 on Card).

**CRAIG SYSTEMS, INC.**, 3600 Merrimack St., Lawrence, Mass.

• GSE SPECIALTIES—lightweight, high-strength, air transportable shelters and trailer vans for housing electronic equipment, communication, navigation, photographic and missile ground sup-

more on next page

# D-C POWER

Precisely Regulated for  
Missile Testing and  
General Use



**CHRISTIE**

## SILICON POWER SUPPLIES

available in 30 standard-  
ized and militarized models  
from 30 to 1500 amps...  
6 to 135 volts. CHRISTIE'S  
QUALITY CONTROL is  
approved by the A.E.C.,  
leading aircraft and missile  
manufacturers.

Write For Bulletin AC-58-A

## CHRISTIE ELECTRIC CORP.

3410 W. 67th Street  
Los Angeles 43, Calif.

Write in No. 87 on Reader Service Card

# 4 Ounce Contact Force Gives Relay Reliability

Contact force of 4 ounces per contact on 50 "G" models and 2 ounces per contact on 30 "G" models of "Diamond H" Series R and Series S miniature, hermetically sealed, aircraft type relays is one of the most important factors in their proven high reliability.

Though absolute reliability of any similar device is impossible to guarantee—a bitter fact of life recognized by all electronic engineers—close approach to this goal by the relays manufactured by

The Hart Manufacturing Company is the basic reason they are found today on many of this country's headline-making missiles.

In addition to contact force far beyond that found on other relays, "Diamond H" relays have greater contact cleanliness. Self-contamination is virtually eliminated by a completely inorganic switch mechanism, as well as use of coil materials which will not dust, flake or out-gas.

Finally, the high degree of reliability that is designed into these relays is maintained in their manufacture by high quality workmanship and a stringent inspection policy at every stage.

In addition to missiles, and their ground control systems, Series R and S relays are designed for use in jet engine controls, computers, fire control, radar and similar critical applications.

4PDT units, they offer an extremely broad range of performance characteristics, including temperature ranges from -65° C. to 125° and 200° C.; ratings to 10 A., 120 V., A. C., and 26½ V., D. C., with special ratings to 400 ma. at 350 V., D. C., or down to millivolts and milliamperes. Dry and wet circuits may be safely intermixed.

**For more information, write today for Bulletins R250 and S260. For quick facts about "Diamond H" switches, thermostats and other devices, ask also for a copy of the "Diamond H" Check List of Reliable Controls.**



THE **HART** MANUFACTURING COMPANY

212 Bartholomew Ave., Hartford 1, Conn.

Phone JACKSON 5-3491

port systems. Layout, installation and checkout of electronic components in shelters and trailer vans.

• **GSE CONTRACTS** — GSE for Hawk, Matador, Thor and Jupiter missiles.

• **GSE LITERATURE** — Electrical Equipment Shelter (No. 744 on Card); 50' Telescoping Antenna Mast (No. 745 on Card); Electrical Equipment Shelter (No. 746 on Card); Trailer Van (No. 747 on Card).

**CROSLEY DIV., AVCO CORP.**, 1329 Arlington St., Cincinnati 25, Ohio.

• **GSE SPECIALTIES**—display consoles, automatic checkout equipment, computing systems, arming and fusing mechanisms; missile shipping containers; missile shelters (Nashville Division); human factors engineering services for ground support equipment; specialized structures involving use of aluminum and stainless steel honeycomb material (Nashville Division).

• **GSE LITERATURE** — Special Brochures (No. 748 on Card).

**DATA INSTRUMENTS DIV., TELE-COMPUTING CORP.**, 12838 Saticoy St., N. Hollywood, Cal.

• **GSE SPECIALTIES** — advance electronic and electro-mechanical design in the fields of control systems and components, data handling, and measurement for ground support and instrumentation. Considerable research in refining and improving techniques of ground measurement, and in developing analog-to-digital converts of improved accuracy. Equipment to digitize shaft position with extreme accuracy.

• **GSE LITERATURE** — Engineering Services (No. 749 on Card).

**DESIGNERS FOR INDUSTRY, INC.**, 4241 Fulton Parkway, Cleveland 9, Ohio.

• **GSE SPECIALTIES** — research, development and production of ground systems for aircraft and missiles, including handling and automatic checkout equipment.

• **GSE CONTRACT** — ABMA: design and manufacture of various test equipment for Redstone guidance system (included a control computer test fixture, program design test fixture, control relay box test fixture, actuator test fixture, standard power supply, and many other units and sub-units not listed here); a tactical version of GSE for operational Jupiter (included such test fixtures as the lateral control unit, lateral pre-set unit, slant range pre-set unit, slant range control unit and the slant range and lateral computer holding fixture). Juno II final test and firing equipment; Minuteman project for Thiokol: program outline for making a complete equipment test of the first stage.

• **GSE LITERATURE** — Systems for Missile Ground Support and Guidance Sub-Systems Brochure (No. 750 on Card); Systems for Radar and Communications Brochure (No. 751 on Card); Electronics and Instrumentation Folder (No. 752 on Card); Ground Support Equipment (Tactical Version) for the Jupiter Missile Brochure (No. 753 on Card).

**DETROIT HOIST & MACHINE CO.**, 8201 Morrow St., Detroit 11, Mich.

• **GSE SPECIALTIES** — design and

more on page 116

*Acme-Newport Steel*

## LEAVES ITS OLD KENTUCKY HOME

### Destination: SPACE!

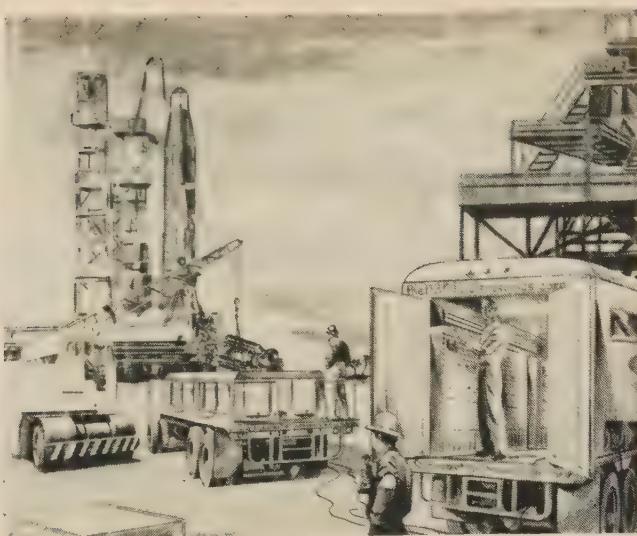


Carefully processed from electric furnace to finished steel, Acme-Newport products take off by fast truck or air freight on their second move toward space. Next stop: prime and subcontractors who continuously employ the long experience, skills and modern facilities of Acme-Newport in the cause of national survival. Alloy and carbon grades in strip, sheet and coil, become components of rockets, missiles, planes and ground support equipment, which permit nothing but perfect performance. Through three-quarters of a century we have supplied quality steel for arms and industry . . . for both of which we ask you to make our facilities your own.

*Acme-Newport Steel*  
COMPANY  
NEWPORT, KENTUCKY  
A SUBSIDIARY OF  COMPANY

*Acme-Newport mills; Cincinnati in background*





*Artist's conception of the Narda SonBlaster® M1 Missile Cleaner. Fully mobile and self-propelled, the new ground support equipment is designed for use at launching pads and missile assembly plants.*

## Ultrasonic Missile Cleaner Announced by Narda

Westbury, L. I. (N.U.)—Introduction of the M1 Ultrasonic Missile Cleaner has been announced by the Narda Ultrasonics Corporation. Designed to be fully mobile and self-contained, the complete equipment includes an air-conditioned van containing all necessary electronic gear and a flat bed trailer in which missiles, jet engines and other large assemblies may be cleaned.

The flat bed trailer is 24 feet long and supports a transducerized tank measuring 20' long by 6' wide by 3' deep, towed by a cab-over-engine type power tractor. Thirty kilowatts input are required by the transducers, paired in 1 kw modules for easy field maintenance and replacement.

Power is supplied to the transducers by 12 Narda SonBlaster G-25001 generators, installed in the rear of the van. All necessary cables and maintenance facilities are included in the van.

This new GSE concept of ultrasonic cleaning has been pioneered by Narda, producers of more ultrasonic cleaners than all other companies put together. It is the latest addition to the SonBlaster line of cleaning and degreasing equipment ranging from 35 watts to 2.5 kw generating power, including transducerized tanks and immersible transducers. More information about the M1 Missile Cleaner, fuel pipe line cleaners, and other SonBlaster ultrasonic cleaners can be obtained by writing Narda at Dept. SA-9.

**the narda ultrasonics corporation**

625 MAIN STREET, WESTBURY, L. I., N. Y. • EDgewood 3-5400  
5785 North Lincoln Ave., Chicago, Illinois • Long Beach 1-4625  
3259 Wilshire Boulevard, Los Angeles 5, Calif. • DUnkirk 8-2201  
Subsidiary of The Narda Microwave Corporation

## CAPABILITIES

production of electric and air hoists and cranes for general purpose and special applications.

- **GSE CONTRACTS** — Holloman AFB: two-motored monorail hoist, electric hoist and trolley; Griffiss AFB: 10 ton capacity crane; Davis-Monthan AFB: ½ ton electric hoist; White Sands Missile Range: two-ton electric hoist with magnet lift.

**DRYOMATIC CORP.**, 806 N. Fairfax St., Alexandria, Va.

- **GSE SPECIALTIES** — study of environmental control of missile and propellant storage and launching areas. Fabrication of mock-up environmental cells.

- **GSE CONTRACTS** — humidity control equipment for Atlas and Nike bases.

- **GSE LITERATURE** — Product Bulletins (No. 754 on Card); Application Data Sheets (No. 755 on Card); Facilities Brochure (No. 756 on Card).

**DURANT MFG. CO.**, 1929 N. Buffum St., Milwaukee 1, Wis.

- **GSE SPECIALTIES** — servo driven digital readout mechanical counting instruments and impulse driven electro-mechanical counting instruments for missile GSE. Special units to order.

- **GSE CONTRACTS** — Redstone Chrysler Missile, Ford Instrument, and others: counting instruments including double bank standard instrument counters; standard single bank counters; electric reset counter; single detent programmer; hermetically sealed electric reset counter; degrees and minutes counter with stops; AC Spark Plug: variations of standard counters for Thor; General Mills and AC Spark Plug: counters for Mace including programmer; AC single bank instrument counters; dual bank counters for reading increasing quantities on either side of reference point.

- **GSE LITERATURE** — Single and Dual Bank Digital Readout Instruments (No. 757 on Card); Impulse Counters (No. 758 on Card).

**EDGERTON, GERMESHAUSEN & GRIER, INC.**, 160 Brookline Ave., Boston 15, Mass.

- **GSE SPECIALTIES** — equipment and engineering services in field operations; instrumentation systems; nuclear telemetry systems; radiation engineering; dosimetry; radiological site surveys scientific photography; timing and firing.

- **GSE CONTRACTS** — AEC: field operations, scientific photography, timing and firing systems, nuclear telemetry systems for Project Rover, classified contract being negotiated for base hardening equipment with DOD prime contractor; NASA: study of flashing light system for geodetic satellite.

- **GSE LITERATURE** — Company Brochure (No. 759 on Card); Systems Engineering Brochure (No. 760 on Card); Facilities Brochure (No. 761 on Card).

**ELECTRIC MACHINERY MFG. CO.**, 800 Central Ave., Minneapolis 13, Minn.

- **GSE SPECIALTIES** — design and manufacture of a-c motors, generators and controls, including high frequency precise power apparatus, for special applications. Emphasis on precise power 400 cycle apparatus to support aircraft and missiles.

more on page 118

SPACE/AERONAUTICS

# Heat Repulsed Here



## Lightweight Silicone Laminates Withstand Continuous 750 F

Ducts, pods, heat-shields, electronic components and other high-temperature parts for missiles or aircraft can be fabricated easily of lightweight silicone laminates. These laminates have good strength, good heat resistance, and are unaffected by moisture, weathering, ozone and corrosion, thermal shock or fungus attack. Dow Corning silicone resins, coupled with glass cloth or other inorganic fillers, give better strength-to-weight ratios "at temperature" than many light metals. And they're simple to form.



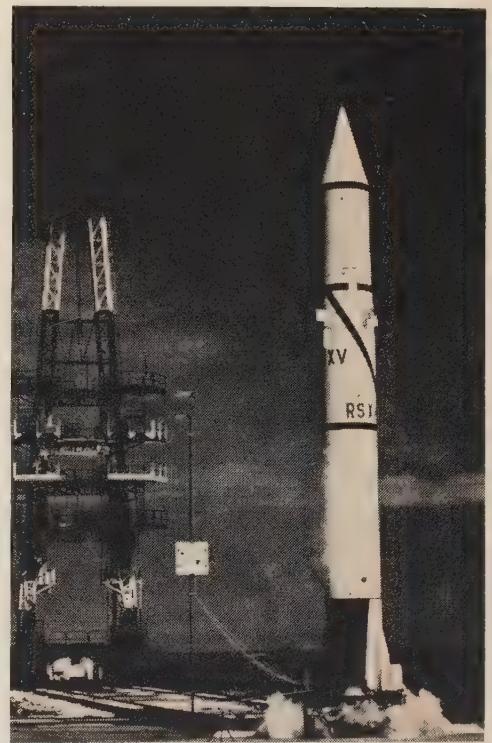
In the North American Aviation Super Sabre F-100, for example, designers needed a rigid material for the drag-chute case. As this chute case fits right up against the engine at the rudder base, the rigid outer wall of it must: 1) reflect heat away from the chute; 2) resist jet engine ambients; 3) retain structural strength without necessity of replacement.

Development engineers tried numerous "high-temperature" plastics without success. Too much heat. Then they hit on silicone-glass laminate, gold-metallized for heat reflectance. Not only did this prove entirely suitable, it also turned out to be more easily formed. The finished part can endure continuous service at 750 F and intermittent exposure to 1200 F. Vibration resistance is excellent.

### Silicones for the Army Redstone

In the Redstone, Chrysler Missile Division engineers employ silicone laminates several ways. As in the case of the F-100, large heat shields behind

the Redstone's engine compartment are fabricated of the laminates because of their light weight, heat resistance, thermal impedance. Also, due to excellent electric strength and creep resistance, silicone laminates are utilized for terminal boards in black boxes within the missile and in Ground Support Equipment control boxes.



For further data and a list of fabricators of silicone laminates, write today to Dept. 0722



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MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

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# BE SURE

## of correct screw or bolt tension with

**Snap-on®**

### Torque Driver

**SNAP-ON** torque drivers are available in three models with attachments to handle a wide range of jobs.

**Model TQS-025** — Capacity: 3 in-lb and 48 in-oz

**Model TQS-050** — Capacity: 6 in-lb and 96 in-oz

**Model TQS-1** — Capacity: 12 in-lb and 192 in-oz

### for Aviation - Electronics - Radio - Television - Radar... any precision assembly work

This  $\frac{1}{4}$ -inch drive SNAP-ON torque driver gives you precise control on jobs where screws or nuts must be tightened to exact tensions. Unit is extremely accurate, regardless of position, or manner of holding.

Easily read dial is calibrated in inch-ounces and inch-pounds and may be adjusted right or left for convenient use. Dial can be used two ways. Either set pointer at desired bolt tension and apply turning pressure to screw or nut until pointer reaches zero, or set pointer at zero and apply pressure until pointer reaches desired calibration on scale.

#### Available with variety of $\frac{1}{4}$ -inch drive attachments

Standard screwdrivers —  $3\frac{1}{4}$ " long:  $\frac{3}{16}$ "x.032",  $\frac{1}{4}$ "x.032", and  $\frac{3}{8}$ "x.042" tips  
 Short screwdrivers —  $\frac{7}{8}$ " long:  $\frac{1}{4}$ "x.032" tip  
 Clutch-type screwdrivers —  $1\frac{1}{8}$ " long:  $\frac{1}{16}$ ",  $\frac{15}{64}$ " and  $\frac{5}{32}$ " bit diameter  
 Phillips screwdrivers — No. 1 and No. 2 bits in various lengths  
 Single hex sockets — 9 sizes,  $\frac{3}{16}$ " to  $\frac{1}{2}$ "  
 Deep single hex sockets — 9 sizes,  $\frac{3}{16}$ " to  $\frac{1}{2}$ "  
 Double hex sockets — 8 sizes,  $\frac{3}{16}$ " to  $\frac{1}{2}$ "  
 Double square sockets — 3 sizes,  $\frac{1}{4}$ " to  $\frac{3}{8}$ "  
 Extensions, ratchet adaptors, etc.

A SNAP-ON Sales Engineer can give you more information on the value of torque drivers and TORQOMETERS® in your production or maintenance work. Well-stocked SNAP-ON Branches are located in every major industrial area. Check your phone book or write us for complete catalog listing the full range of wrenches and hand tools.

**SNAP-ON TOOLS**  
CORPORATION

8080-J 28th Avenue • Kenosha, Wisconsin

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- GSE CONTRACTS—Nike-Hercules sites: motor generator sets—56.3 kva 1200 rpm 400 cycle generator driven by a 60 cycle synchronous motor; Snark Base: motor generator sets 62.5 kva, 1200 rpm, 400 cycle synchronous generator driven by a 60 cycle synchronous motor; Army: 56.3 kva, 1846 rpm, 400 cycle generators with magnetic amplifier type voltage regulator and static exciter.

- GSE LITERATURE—ABC of 400 Cycle Generators and Their Control (No. 762 on Card).

**EPSCO, INC.**, 275 Massachusetts Ave., Cambridge, Mass.

- GSE SPECIALTIES—ultra-high speed automatic checkout systems for testing, measurement, analysis, and control applications where extreme high speed is essential. Designs for master checkout systems (similar to Raco), field operational systems, mobile field test systems, sub-system test systems, and a component test system. Automatic monitoring system.

- GSE CONTRACTS—AC Spark Plug: automatic checkout system for the Thor guidance system; Douglas: automatic checkout system for Nike-Zeus subsystems; Convair-Pomona: automatic checkout system for Terrier.

- GSE LITERATURE—The Raco System Design Study Brochure (No. 763 on Card).

**EXECUTONE, INC.**, 415 Lexington Ave., New York 17, N.Y.

- GSE SPECIALTIES—design of specialized voice communication systems for testing and control setups used for missile check-out, countdown and observation (both telephonic and electronic).

- GSE LITERATURE—1100D Fully Intercommunicating System (No. 764 on Card); A New Concept in Sound Systems (No. 765 on Card); Overcoming High Noise Levels (No. 766 on Card); Explosion-Proof Equipment (No. 767 on Card).

**FAIRCHILD ASTRIONICS DIV., FAIRCHILD ENGINE & AIRPLANE CORP.**, Wyandanch, N.Y.

- GSE SPECIALTIES — automatic go-no-go missile system and subsystem checkers; operational ground complexes; field checkout equipment; and launching systems.

- GSE CONTRACTS—Goose: test and operation consoles automatic programmer with tape reader, circuit selector, accessory circuits, and tape verifier; a status panel; missile selector panel; and automatic checkout circuits. Recent missile project: special GSE including fully equipped huts for launch control and date display. Test equipment for forward echelon includes a go-no-go checker for each subsystem and for the system as a whole. Rear bases equipped for more complete functional testing of components and units and for test and rehabilitation of defective systems.

- GSE LITERATURE—Capabilities Brochure (No. 768 on Card).

**FAIRCHILD CAMERA & INSTRUMENT CORP.**, 300 Robbins Lane, Syosset, N.Y.

- GSE SPECIALTIES—pulse, semiconductor, video and high frequencies, optics and servo techniques for original development of highly complex GSE. Past developments include a system for a

more on page 122

SPACE/AERONAUTICS

*that  
God's  
earth  
and  
man's  
genius  
shall  
surely  
part . . . . .*

*research • development  
design • prototypes  
testing • production*



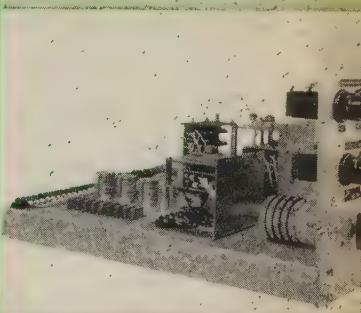
Assembly test stand for transporting and restraining missiles during depot checkout procedure.

Simulating deck of rolling ship to test stability and brake system of missile transfer equipment.



Hydraulic Mating Unit, part of complete automatic strike-down and mating system for TALOS.

Electronic trouble detection and safety control unit designed and manufactured by WTA.

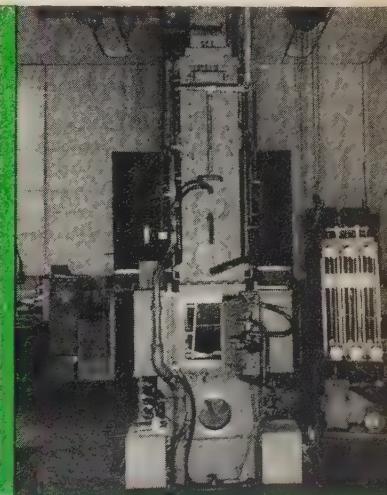


## *... look to specialists in ground support equipment*

*handling • containing • launching • training  
test and check-out • safety and automatic controls*

One touch of engineering genius, with two feet firmly on the ground, can mean a great future for you at WTA!

Portions of this wind tunnel installation were designed and fabricated by WTA.



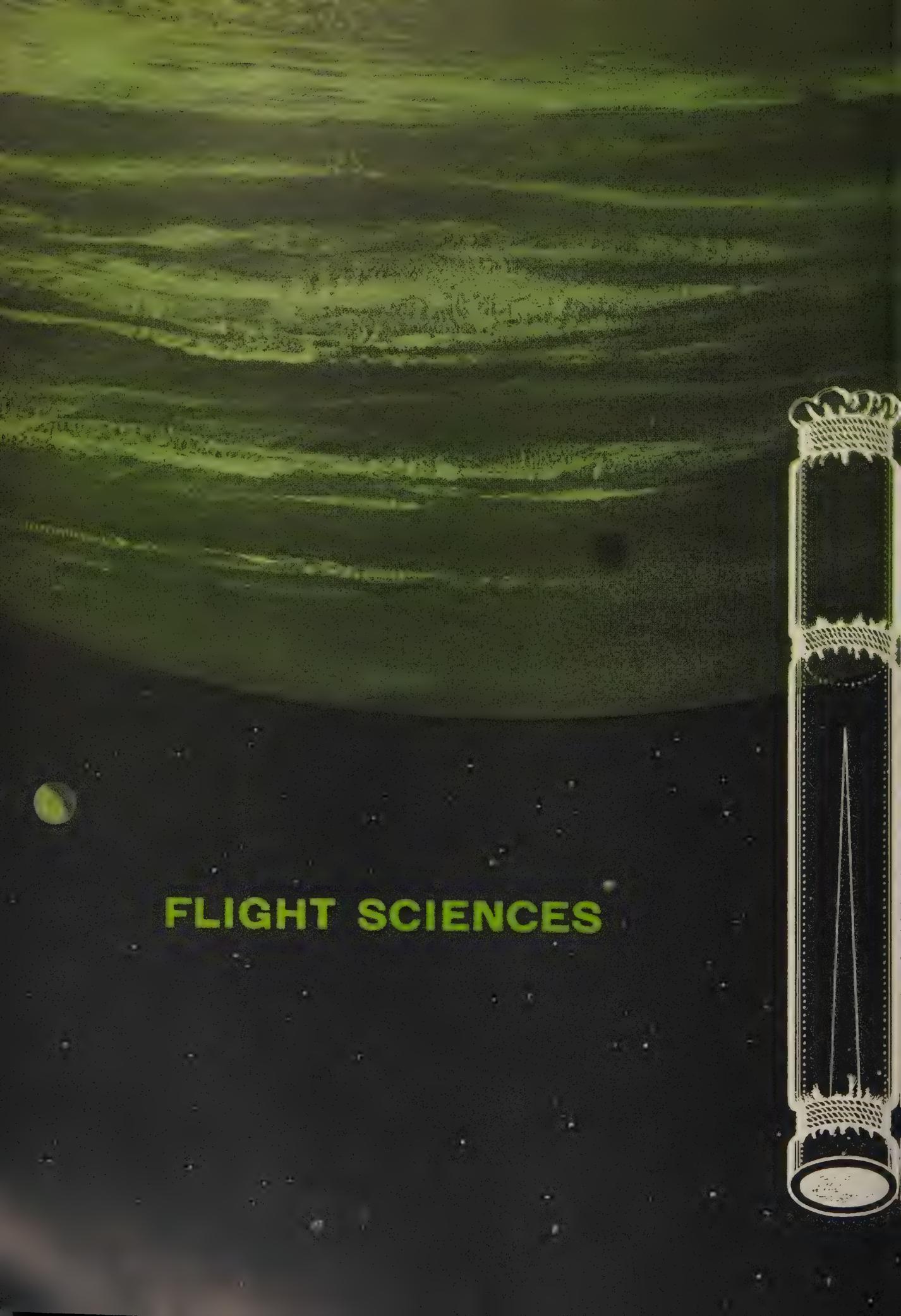
**WASHINGTON  
TECHNOLOGICAL  
ASSOCIATES, INC.**

979 Rollins Avenue • HA 7-7550  
Rockville, Maryland The "All America" City

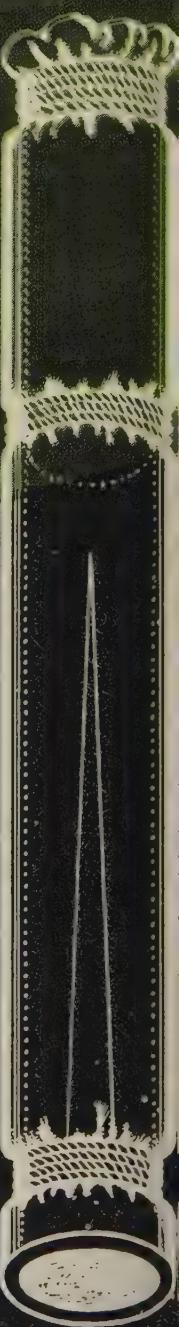


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# FLIGHT SCIENCES





**FLIGHT SCIENCES:** Principle of the step or multi-stage rocket, considered fundamental to the art of modern missiles and space flight, was set forth as long ago as 1650 by Kazimierz Siemienowicz, lieutenant-general of ordnance to the king of Poland. His design featured a 3-stage rocket with each step having its own gunpowder fuel, fuse, and nozzle.

## EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Pioneering work at Lockheed is being conducted in free molecular flow in orbital flight; high altitude atmospheric properties; trajectory studies and missile flight dynamics; celestial mechanics with emphasis on orbital tracking predictions and de-orbiting.

Lockheed's capabilities in gas dynamics and thermodynamics are unsurpassed in private industry. Basic work is being performed in boundary layer flow and heat transfer; cooling and insulation; thermodynamic flight test; instrumentation; rocket motor controls and nozzle structures; reentry and materials; thin film thermometry; and measurements of dissociation and re-combination reactions.

Fundamental studies include hypersonic aerodynamics; environmental effects on satellite surfaces; magnetohydrodynamics; ultra-violet and infrared radiation from high temperature air flows; structure of hypersonic shock waves; new measurement methods; analysis of boundary layers near melting surfaces and study of lag or non-equilibrium in high speed flow through shock waves.

Equipment includes an electrically-driven wind tunnel—fastest in industry—which produces airflows to Mach 20-plus and stagnant temperatures approaching 16,000°F, with an instantaneous power output of 20 million kilowatts. A spark-heated, magnetically driven research shock tube produces velocities of over Mach 250 and temperatures of 500,000°F, and a specially designed, electric gun has accelerated projectiles to speeds approaching 20,000 ft/sec.

Major emphasis in structures concerns the design of reentry bodies, thrust termination and underwater launching devices. The Navy Polaris FBM required the solution of complex structural problems necessitated by the unique launching environment—water.

Other significant work has been accomplished in diversified aspects of aerodynamic and hydrodynamic load distribution, aeroelastic effects, studies of special dynamic problems arising from aerodynamic disturbances, cavitation, launching conditions and thermal problems relating to analysis of a complex structure taken through a complete time-temperature environment.

Lockheed Missiles and Space Division programs reach far into the future and deal with unknown environments. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. J-16, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

## *Lockheed* MISSILES AND SPACE DIVISION

*Weapons Systems Manager for the Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; and Air Force Q-5 and X-7*

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CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

## CAPABILITIES

# FROM BLUEPRINT TO REALITY

Active in the missile and aircraft fields since their beginnings, the Falstrom Company, one of America's leading metal fabricators, has helped in some small measure to launch the space age.

Produced in accordance with

the most stringent MIL Specs,

FALSTROM METAL FABRICATIONS

—such as housings, chassis, weldments, and custom metal components—are being specified for many applications in the aircraft industry.

Falstrom engineered fabrications are offered in standard metals as well as special light-weight alloys.

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## FALSTROM COMPANY

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Prescott 7-0013

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complete checkout of high resolution closed loop television system; a radar target simulator; an automatic voice data link; an electronic near hit and miss distance indicator; and a nuclear reactor simulator.

• GSE CONTRACTS—Ford Instrument GSE for Jupiter radar tracking and guidance system; AF; high resolution processing equipment for a high acuity camera system; camera, processor, viewer, CRT display and monitoring equipment for a photo-transmission system.

• GSE LITERATURE—Training Systems and Ground Support Equipment for Missiles, Manned Aircraft and Drones (No. 769 on Card).

**FIRESTONE TIRE & RUBBER CO.**, 2525 Firestone Blvd., Los Angeles 54, Cal.

• GSE SPECIALTIES—engineering and production of mobile missile field equipment, submarine launching equipment, and fixed based installations.

• GSE CONTRACTS—All handling and servicing equipment for Corporal; Regulus missile launcher and monitoring systems for submarines; shock and vibration mitigation system for Polaris; maintenance and repair equipment for Corporal electronic test consoles for Minuteman guidance system.

• GSE LITERATURE—Company Capabilities (No. 770 on Card).

**FOREMAN MANUFACTURING CO.**, 5353 S. State St., Chicago 9, Ill.

• GSE SPECIALTIES—Design and manufacture of special trailers for cargo handling. Trailer undercarriage subassemblies.

**THE GARRETT CORP., AIRESEARCH MFG. DIV.**, 9851 Sepulveda Blvd., Los Angeles 45, Cal.

• GSE SPECIALTIES—Gas turbine engines for mobile power plant operations to provide electrical power (for missile component test, preflight test, ground control and electronic control testing, equipment cooling and heating systems, freon air conditioning systems and lighting); pneumatic power (for air motor systems, heating, generating plants, preflight deicing, pressurization, air cycle air conditioning and pneumatic control systems); and hydraulic power (to check flight controls, actuate launch platforms and hoisting).

• GSE CONTRACTS—Sperry-Utah: gas turbine generator for Sergeant missile complex.

• GSE LITERATURE—Power Turbo Machinery Catalog (No. 772 on Card); AiResearch Gas Turbine Power Unit (No. 773 on Card); Reliability of AiResearch Gas Turbines (No. 774 on Card); AiResearch Ground Support Systems (No. 775 on Card).

**GENERAL CABLE CORP.**, 730 Third Ave., New York 17, N.Y.

• GSE SPECIALTIES—Wire and cable and cable assemblies for ground support power, control and communications. Also 250 deg C mineral insulated cable (NEC Type MI) in which one or more electrical conductors are insulated with a highly compressed refractory mineral insulation and enclosed in a liquid-tight and gas-tight metallic tube sheathing.

• GSE CONTRACTS—Electric Boat:

watertight shipboard cable for Polaris; Titan: cable for power and control.

• GSE LITERATURE—Video Pair Cable (No. 776 on Card); Telephone Cables (No. 777 on Card); Power, Lighting & Control Cables (No. 778 on Card); Safety Mineral Insulated Cable (No. 779 on Card); High Frequency Cables (No. 780 on Card).

**GENERAL ELECTRIC CO., MISSILE & SPACE VEHICLE DEPT.**, 3198 Chestnut St., Philadelphia 4, Pa.

• GSE SPECIALTIES—support for ballistic missile nose cones, including instrumentation checkout vans, gas pressurizing trailers, dollies, nose cone handling equipment.

• GSE CONTRACTS—GSE as included in the scope of ballistic nose cone research and development contracts. Also arming and fusing adaptations kits for several Army missiles.

• GSE LITERATURE—PIB-3 High Frequency Experiments Instrumentation Van (No. 781 on Card).

**GENERAL LOGISTICS DIV., AEROQUIP CORP.**, 2929 Floyd St., Burbank, Calif.

• GSE SPECIALTIES—Cargo tie-down and control equipment for aircraft and missiles (web straps and buckles, chain tie-downs, all sorts of rope and web nets).

• GSE CONTRACTS—Convair: missile drop test net; Navy: chain tie-downs to hold jets on aircraft carriers during full power run up; nylon strap harness to secure top heavy rocket thrust chambers on pallets.

• GSE LITERATURE—Strap and Buckle Tie-Down Equipment (No. 782 on Card); Cargo Tie-Down Equipment (No. 783 on Card); Aeroquip Ratchet Buckle (No. 784 on Card); Missile Tie Down (No. 785 on Card).

**GENERAL MILLS, INC., MECHANICAL DIV.**, 1620 Central Ave. N.E., Minneapolis 13, Minn.

• GSE SPECIALTIES—Design and fabrication of electrical and electronic checkout equipment. Equipment for calibration, test and checkout of missile subsystems, aircraft radar systems and weapon systems. Equipment for remote service of nuclear powered aircraft.

• GSE CONTRACTS—electronic and mechanical GSE for airborne electronics system (classified) provides for calibration test and checkout of all optical devices, the data handling unit and stable platforms in the weapon system includes all ground handling equipment. AF: portable radar system tester AN/GPM-25 for bombing radar systems (can be adapted to test navigation and weather radars). Production units for testing APS-64, ASB-4, APS-23 and other radar systems. GSE for airborne weapon (classified) to ground test and checkout, test sets are concerned with continuity of electrical circuitry, timing functions, leakage resistance, insulation resistance, and overall function of components as well as the complete weapon.

• GSE LITERATURE—GSE Brochure (No. 786 on Card).

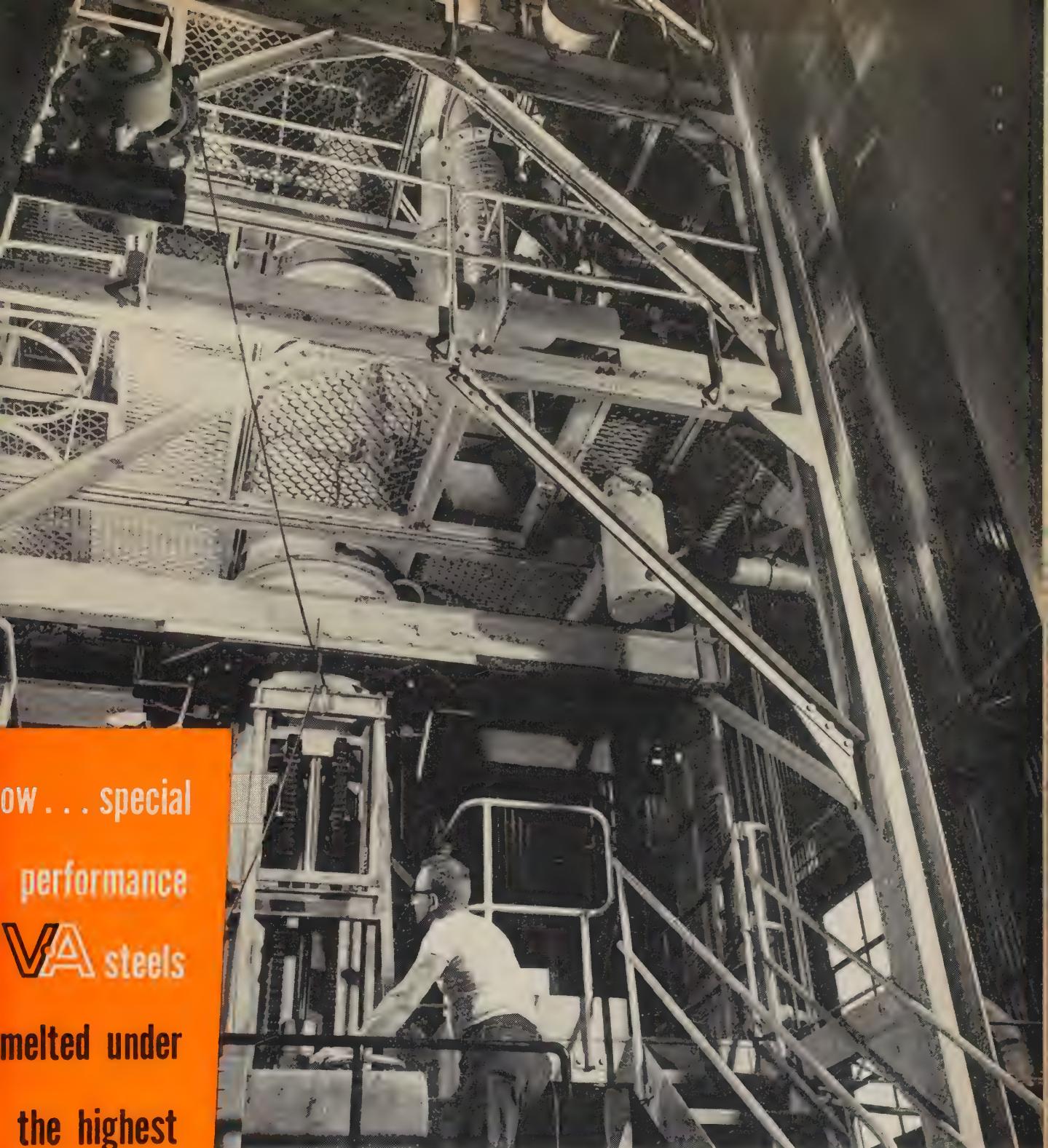
**THE B. F. GOODRICH CO.**, 500 So. Main St., Akron 18, Ohio

• GSE SPECIALTIES—pneumatic shipping containers; missile covers; elec-

more on page 124

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SPACE/AERONAUTICS



Now . . . special  
performance  
**VA** steels  
melted under  
the highest  
vacuum  
obtainable  
in the  
industry today  
3 microns pressure)

The steels from our unique consumable electrode (CVM) vacuum melting furnace open a new phase in the aircraft, missile, steam turbine and other fields where utmost steel cleanliness and lengthened fatigue life are vital to higher performance. We will be happy to prove to you where these CVM Steels, and those produced by our Induction Vacuum Melting processes, can do far more for your needs than their difference in cost would indicate. Write for new brochure.



**Vanadium-Alloys Steel Company**  
LATROBE, PENNSYLVANIA

**DIVISIONS:** Anchor Drawn Steel Co. • Colonial Steel Co. • Metal Forming Corporation • Pittsburgh Tool Steel Wire Co.

**SUBSIDIARIES:** Vanadium-Alloys Steel Canada Limited • Vanadium-Alloys Steel Societa Italiana Per Azioni • EUROPEAN

**ASSOCIATES:** Societe Commentryenne Des Aciers Fins Vanadium-Alloys (France) • Nazionale Cogne Societa Italiana (Italy)

## CAPABILITIES

trically heated rubber heaters for solid and liquid propellants; instrument heaters; wheels, brakes, tires; shipment and storage products and materials; elastic suspension for launching devices; rubber parts for missile shelters; etc.

- GSE LITERATURE—Resources for Missile and Rocket Progress (No. 787 on Card).

### HAMILTON STANDARD DIV., GSE DEPT., UNITED AIRCRAFT CORP., Windsor Locks, Conn.

• GSE SPECIALTIES—system design and management; operational test and checkout equipment; automatic sequencing equipment; specialized maintenance equipment; ground servicing equipment; fixed facilities; and transport and handling equipment.

- GSE CONTRACTS—NAA: GSE for F-108 and B-70 environment control system; GSE for B-70 air induction control system.

• GSE LITERATURE — Hamilton Standard GSE Department Capabilities (No. 957 on Card).

### HARBISON-WALKER REFRactories CO., 307 Fifth Ave., Pittsburgh 22, Pa.

• GSE SPECIALTIES—development of refractories castable to requirements of missile launching platforms. Super-duty refractory brick pavements for jet aircraft and warm-up pads and runways.

• GSE CONTRACTS — Super-duty fireclay brick and castable refractory for launching pads, rocket testing stands, and warm-up aprons.

- GSE LITERATURE — H-W Castables Brochure (No. 788 on Card); ALAMO Super-duty Fireclay Brick Brochure (No. 789 on Card).

### THE HARTMAN ELECTRICAL MFG. CO., 175 N. Diamond St., Mansfield, Ohio

• GSE SPECIALTIES — custom relay and electrical controls, standard AC controls, three phase high capacity contactors, over-and under-frequency and voltage relays, and load protector relays, miniature and sub-miniature relays.

• GSE CONTRACTS — F-102, F-106: contactors, overvoltage relays, frequency relays, phase rotation detection relays, motor protectors, reverse current cutouts; MD-3 and MD-3A Standard Military Ground Power Cart: all relays and contactors, protection relays and controls and a dynamic breaking control assembly; Titan: large number of the AC and DC contactors and controls, frequency voltage and current relays; Matador: power distribution panels containing relays, contactors, necessary bussing, breakers and switches, and a number of other relays.

### C. G. HOKANSON CO., INC., 2140 Pontius Ave., Los Angeles 25, Cal.

• GSE SPECIALTIES — specialized air conditioning equipment. Mobile or semi-portable units for minus 6°F. to 130°F.

• GSE CONTRACTS — Douglas: trailer mounted multi-purpose air conditioners for Thor bases. Convair: mobile air conditioners for B-58. Martin: combination chillers and air conditioners on Titan.

- GSE LITERATURE — Tailored Atmosphere by Hokanson (No. 790 on

more on page 126

# FIRST THOUGHT for Mobility CARAVAN AXLES

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United Caravan Axles and Running Gear assemblies are designed and engineered to meet your most exacting specifications.

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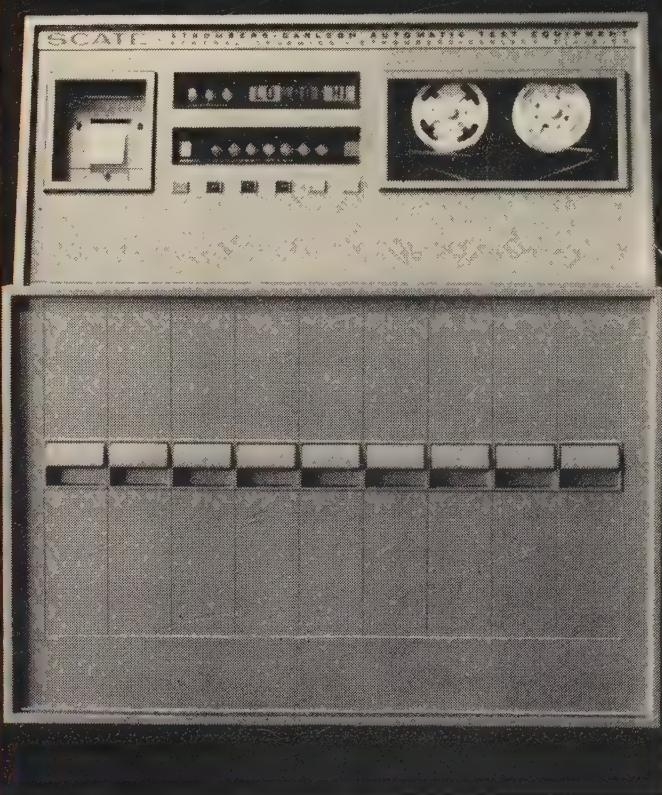
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SPACE/AERONAUTICS



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Automatic Test Equipment**

- Completely solid state; modular.
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ELECTRONICS AND COMMUNICATION FOR HOME, INDUSTRY AND DEFENSE

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## CAPABILITIES

Card); Comfort Zone—Hokanson Mobile Air Conditioners (No. 791 on Card); Hokanson Leader in Missile Support Air Conditioning (No. 792 on Card; Hokanson H-35 Air Conditioner (No. 793 on Card).

**HOLEX INC.**, 2751 San Juan Rd., Hollister, Cal.

- **GSE SPECIALTIES** — Engineering and consulting service for missile ordnance systems and associated electrical and electronic initiation control circuitry. Design, manufacture and test of specialized ordnance items such as explosive bolt cartridges, pressure cartridges, gas generators and inert devices related to packaged explosive power sources. Also fused ceramic to metal thread-in electrical feed through terminals for high pressure, high temperature application.

- **GSE CONTRACTS**—Polaris: 4000 psig reloadable explosive valve used as pilot dump valve for 6-inch launch valve; explosion proof guillotine to cut acid fueling hose prior to missile launch; Titan: explosive bolt cartridge which severs launch bolts holding missile to the launching pad.

- **GSE LITERATURE** — Technical Data Brochure (No. 794 on Card); Explosive Components and Ground Support (No. 795 on Card).

**LUDWIG HONOLD MFG. CO.**, Chester Pike & Folcroft Ave., Folcroft, Pa.

- **GSE SPECIALTIES** — design and prototype testing of precision housings and containers for electronic and mechanical GSE; design, production and test of reusable shipping and storage containers.

- **GSE CONTRACTS** — Reusable shipping container for Lacrosse airframe; operational console for Atlas cabinets for standardized organizational maintenance tool sets.

- **GSE LITERATURE** — Facilities and Personnel Brochure (No. 796 on Card); Illustrated Catalog (No. 797 on Card).

**HORKEY-MOORE ASSOC.**, 24660 S. Crenshaw Blvd., Torrance, Cal.

- **GSE SPECIALTIES** — ground handling equipment (trailers, dollies, hoists, jacks, hydraulics and pneumatics).

- **GSE CONTRACTS**—Hound Dog: ammonia servicing trailer. NAA Autonetics inertial guidance system: about 250 heat exchangers.

- **GSE LITERATURE** — Company Capabilities in GSE (No. 798 on Card); Resumes of Key Engineers with Ground Support Equipment Background (No. 799 on Card); Environmental and Qualification Testing Facilities (No. 800 on Card).

**HUGHES TOOL CO., AIRCRAFT DIV.**, Florence & Teale St., Culver City, Cal.

- **GSE SPECIALTIES** — field check-out and production test equipment for jet aircraft and missiles. Divers electronics, electro-mechanical, hydraulic, pneumatic, structural, temperature control, air conditioning, and hi-temperature systems.

- **GSE CONTRACTS** — propellant utilization and loading system for Atlas (Acoustica Assoc.).

- **GSE LITERATURE** — Facilities

more on page 129

# STAINLESS STEEL TUBING

Pressures demanded by missile, rocket and supersonic aircraft hydraulic and pneumatic systems of current military specifications are emphatically resisted by dependable PATCO stainless steel tubing.

PATCO Stainless Steel Tubing, as well as PATCO Carbon and Alloy Steel Tubing, is produced in lengths up to 58 feet. PATCO also produces cold drawn bars—rounds, squares, hexagons—in carbon and alloy steels. Your orders for stainless, carbon or alloy steel tubing, as well as cold drawn bars, are promptly shipped when sent to either Pacific Tube or your local Steel Service Center.

Next time, specify  
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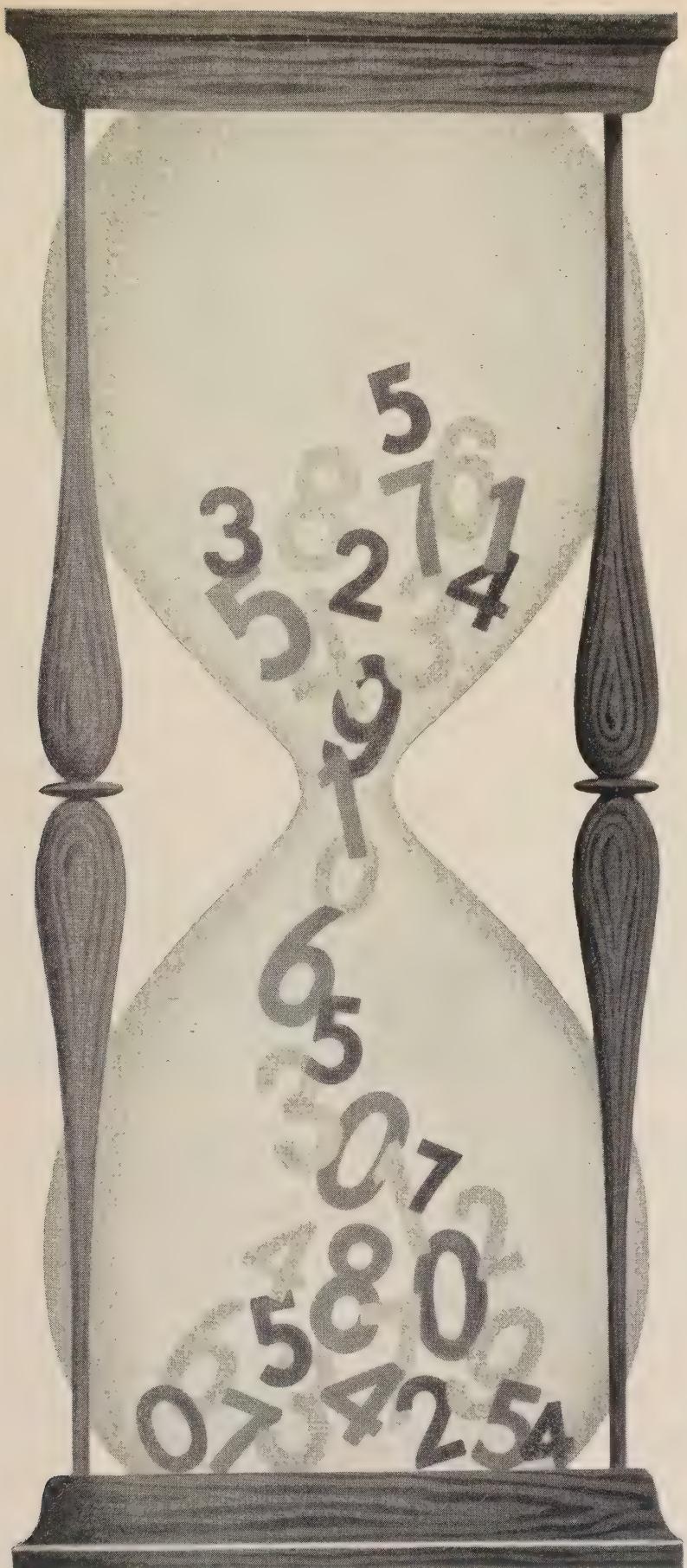
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ARMA research and development has made the digital computer truly airborne. ARMA, Garden City, N. Y., a division of American Bosch Arma Corporation ... the future is our business.

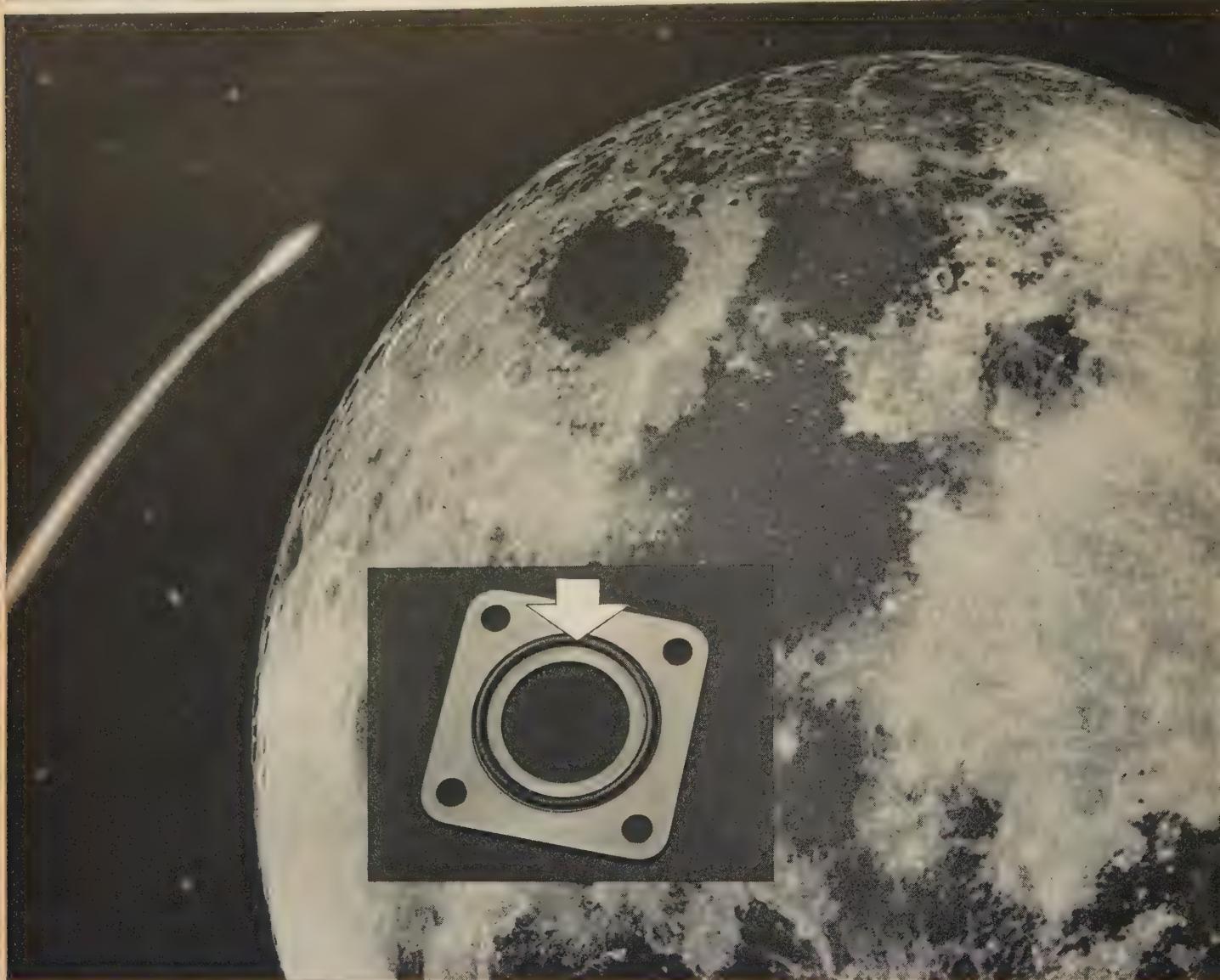
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A rocket's fueling system is its lifeline. That's why Parker Seal Company, a division of Parker-Hannifin Corporation, has chosen KEL-F Brand Halofluorocarbon Elastomer 5500 for the sealing element (arrow) in its Gask-O-Seals to withstand RFNA and WFNA. Parker also provides O-Rings of this material for many types of service.

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Elastomer works wonders with hot lubricants.

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SPACE/AERONAUTICS

## CAPABILITIES

and Capabilities Brochure (No. 801 on Card); Test Equipment Brochure (No. 802 on Card); Missile and Aircraft Pneumatic and Hydraulic Components (No. 803 on Card).

**HUNTER MFG. CO.**, 30525 Aurora Rd., Solon, Ohio

- GSE SPECIALTIES—Mobile heating and airconditioning equipment for missile control systems and rear echelon repair and maintenance vehicles.

• GSE CONTRACTS—Hughes Aircraft: gasoline burning, thermostatically controlled cabinet heater for the AN/MSG-4 system; Goodyear Aircraft: space and personnel heater for TM61B communications system; Western Electric: combustion heaters for Nike Hercules ground control equipment.

• GSE LITERATURE—Space and Personnel Heaters (No. 804 on Card); Winterization Systems (No. 805 on Card); Instant Lighting Torches (No. 806 on Card).

**INDUSTRIAL ACOUSTICS CO., INC.**, 341 Jackson Ave., New York 54, N.Y.

• GSE SPECIALTIES—jet engine exhaust noise suppressors for run-up, test stand, and test cell applications.

• GSE CONTRACTS—BuAer Portable jet engine exhaust suppressors.

• GSE LITERATURE—Directly Attached Ground Jet Noise Suppressor (No. 807 on Card); Trailer Mounted Ground Jet Noise Suppressor (No. 808 on Card); Directly Attached Ground Jet Noise Suppressor (No. 809 on Card); Acou-Stack Bulletin (No. 810 on Card); Dura-Stack Installation Brochure (No. 811 on Card); Institutional Brochure (No. 812 on Card).

**ITT FEDERAL DIV., INTERNATIONAL TELEPHONE & TELEGRAPH CORP.**, 3301 Wayne Trace, Fort Wayne, Ind.

• GSE SPECIALTIES—System management for automatic test and launch control equipment for large-scale programs early in the planning state. Covers detailed maintenance concept, human factor requirements, test philosophy, specifications, reliability program, design applications, development and production.

• GSE CONTRACTS—Boeing operational test equipment for Bomarc; Sylvania: automatic test equipment for B-58 countermeasures system; International Electric: systems design of maintenance and checkout equipment for SAC Control System (465-1).

• GSE LITERATURE—Weapon Support Systems (No. 813 on Card).

**JAMES, POND & CLARK, INC.**, 2181 E. Foothill Blvd., Pasadena 8, Calif.

• GSE SPECIALTIES—precision check, relief, shutoff, shuttle, and special valves.

• GSE Contracts—Valves used on Atlas, Bomarc, Vanguard.

• GSE LITERATURE—Valve Brochure (No. 814 on Card).

**KAIER ALUMINUM & CHEMICAL CORP.**, 1924 Broadway, Oakland, Calif.

• GSE SPECIALTIES—Technical assistance service to GSE contractors in materials, fabricating processes, and design.

• GSE CONTRACTS—Material research and development for Frankford and Redstone Arsenals.

• GSE LITERATURE—Aluminum in the Defense Industry (No. 815 on Card); Aluminum in Cryogenics (No. 816 on Card); The New 5000 Series Aluminum Alloys (No. 817 on Card)

**KAIER ENGINEERS DIV., HENRY J. KAIER CO.**, 1924 Broadway, Oakland, Cal.

• GSE SPECIALTIES—Design and construction of missile launch bases.

• GSE CONTRACTS—Minuteman facilities (test and operational): engineering studies, development of criteria requirements and concepts and detail design and preparation of construction drawings and specifications; Midas: study-site investigation and selection, design criteria for ground station and base support components including layout and cost estimates of all structures, roads and utilities; Navy: guided missile checkout facilities; LOX, storage and transfer facilities.

• GSE LITERATURE—Company Projects Brochure (No. 818 on Card).

**KAIER STEEL CORP.**, Box 6997, Los Angeles 22, Cal.

• GSE SPECIALTIES—test towers, erector towers, umbilical towers, fixed and portable launching towers, dollies, flame deflectors, fuel tanks, and structures to house equipment at test bases, etc.

• GSE CONTRACTS—Martin: pre-launch checkout platform for Pershing; Convair: missile service towers, high pressure missile pneumatic service trailer; Army: service tower for Saturn.

• GSE LITERATURE—Company GSE Projects (No. 819 on Card).

**KATO ENGINEERING CO.**, 1415 First Ave., Mankato, Minn.

• GSE SPECIALTIES—generators and power converting motor-generator sets for electrical GSE.

• GSE CONTRACTS—many sub-contracts for Hollingsworth, Raytheon, Sperry, Libby Welding and others.

• GSE LITERATURE—400 Cycle Motor Generator Sets (No. 820 on Card); Kato Generators (No. 821 on Card); AC Brushless Generators (No. 822 on Card).

**WALTER KIDDE & CO., INC.**, 675 Main St., Belleville, N.J.

• GSE SPECIALTIES—Fire protection and detecting equipment, fiberglass structures, air compressor carts and pneumatic equipment for pressures up to 5000 psi (air compressors, steel and fiberglass containers, solenoid and manual valves, moisture separation and drying equipment, pressure regulating equipment, modulation and servo valves, pneumatic actuators and ball screwjacks).

• GSE CONTRACTS—Convair-Pomona: gasoline engine driven air compressors to furnish ground support for Terrier; Goodyear Aircraft: air compressor packages for Atlas; Consolidated Western Steel: high pressure air bottles for Nike launcher; Raytheon: electronic, hydraulic, electro-mechanical and straight machine shops in air transportable vans for Hawk system.

• GSE LITERATURE—Portable Ground Service Carts (No. 823 on Card); Fiberglass Containers (No. 824 on Card); Ball Screwjacks (No. 825 on Card); Research, Development and Laboratory Testing Capabilities (No. 826

more on next page



**VITAL ROLE** of KEL-F Plastic in aircraft and missiles applications is represented by these relay coil forms, produced by American Molded Products Co., Chicago, Ill. The combination of characteristics in the Plastic makes these parts more than a match for missiles requirements. The Plastic performs without softening or warping over extreme temperatures, ranging from -320° to +390° F. It has exceptional dimensional stability, zero moisture absorption, high dielectric strength. Tough, workable KEL-F Plastic also exhibits remarkable chemical stability.

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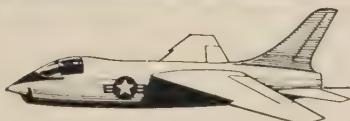
For free literature, write on your company letterhead, specifying your area of interest, to 3M Chemical Division, Dept. KAO-109, St. Paul 6, Minnesota.



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# Forging Eliminates PROFILE Machining

18 inch  
aluminum  
impeller



This big 18" aluminum\* impeller was originally *machined* from a rough forging...requiring many costly man-hours. Then Arcturus, utilizing techniques they have pioneered, developed a method for *forging* the vanes to the finished state shown above...saving considerably on material, eliminating all profile machining and reducing the cost of the finished part substantially. Grain flow follows the contour of the part, providing greatest possible strength.

This was no minor achievement as the impeller was an exceptionally difficult part to make by any known method. The vanes are approximately 3" high and less than 1/16" thick, yet extremely close tolerances were held.

Very likely, that machined part you are designing could be *forged* by Arcturus far more efficiently. We work in most metals and high temperature alloys. Send us your drawings and specifications today for further information.

\*Can also be forged from many high-strength alloys.

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## CAPABILITIES

on Card) Report on Hawk Missile System (No. 827 on Card).

**LAWRENCE PUMPS, INC.**, 371 Market St., Lawrence, Mass.

- GSE SPECIALTIES—Liquid oxygen pumps.
- GSE CONTRACTS—liquid oxygen pumps for Cape Canaveral.
- GSE LITERATURE — Lawrence Chemical and Process Pump (No. 828 on Card).

**LEAR, INC.**, 110 Ionia Ave., N.W. Grand Rapids 2, Mich.

• GSE SPECIALTIES — Applied research, design, development, production, qualification, logistic support and field engineering services for GSE products. Missile programming, data processing, electronic and hydraulic system analyzers, universal electro-mechanical test equipment, AC and DC power supplies, recorders, scorsbys, dynamometers, rate tables, jigs, fixtures, and ground handling equipment.

• GSE CONTRACTS—AF: development of design parameters for universal electro-mechanical GSE for linear actuators, screwjacks, rotary actuators, power units, AC and DC motors. AF: universal depot level electro-mechanical GSE; AF: aircraft GSE for field and organizational level maintenance.

• GSE LITERATURE — Lear GSE Products and Facilities (No. 829 on Card); Continuously Variable Rate Table (No. 830 on Card); Lear Operational Assistance and Instructive Data Equipment (No. 831 on Card).

**LOEWY-HYDROPRESS DIV., BALDWIN-LIMA-HAMILTON CORP.**, 11 Fifth Ave., New York 3, N.Y.

• GSE SPECIALTIES—missile handling, launching and tracking equipment (for static test and flight-firing installations; shipboard, ground, and railroad launching; weight recording; and stowage). Ship-motion simulators.

• GSE CONTRACTS — Talos and Tartar warhead handling and stowage systems; Terrier twin sets of missile-booster handling equipment engineering assistance during installation aboard aircraft carriers.

• GSE LITERATURE—Missile GSE (No. 832 on Card).

**MC MANUFACTURING CO.**, 118 Indianwood Rd., Lake Orion, Mich.

• GSE SPECIALTIES — pneumatic and hydraulic devices including portable compressor units, hydraulic and pneumatic test stands, selector valves, relief valves, shut-off valves, pumps, and complete systems.

• GSE CONTRACTS — Martin shutoff valves; General Mills; air compressors.

• GSE LITERATURE—MCA 101 Circular (No. 834 on Card).

**MARMAN DIV., AEROQUIP CORP.**, 11214 Exposition Blvd., Los Angeles 64, Cal.

• GSE SPECIALTIES — Conoseal joints and similar ducting components for fuel, pneumatic, ventilating system, etc.

**THE MARTIN CO.**, Baltimore 3, Md.

• GSE SPECIALTIES — missile aircraft, and ground based complex GSE

more on page 132

SPACE/AERONAUTICS

# KAYLOCK NUTS.. BUILT TO "PLAY WITH FIRE!"

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America's most powerful Turbojet Engine points its nose at Mach 3. At these speeds, critical components endure enormous stresses. Fasteners must be built to literally play with fire. That's why Kaylock high tensile, all metal, lightweight, self-locking nuts—1,050 per unit—were entrusted to fasten components of the compressor rotor of this high performance engine.

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**RELIABILITY**—every thread carries its full load. Kaylock nuts have no weakening slots. No built in "stress raisers."

**LIGHTER**—Kaylock Jet Engine Nuts are approximately 50% lighter than old style nuts.

**SMALLER**—Kaylock nuts have smaller envelopes. Use smaller wrenches. Permit bolt center line to be moved closer to load.

**SELF-LOCKING**—Resilient, elliptical locking device maintains consistent self-locking torque.

TYPICAL KAYLOCK  
ENGINE NUTS



H14



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K19062



K19063



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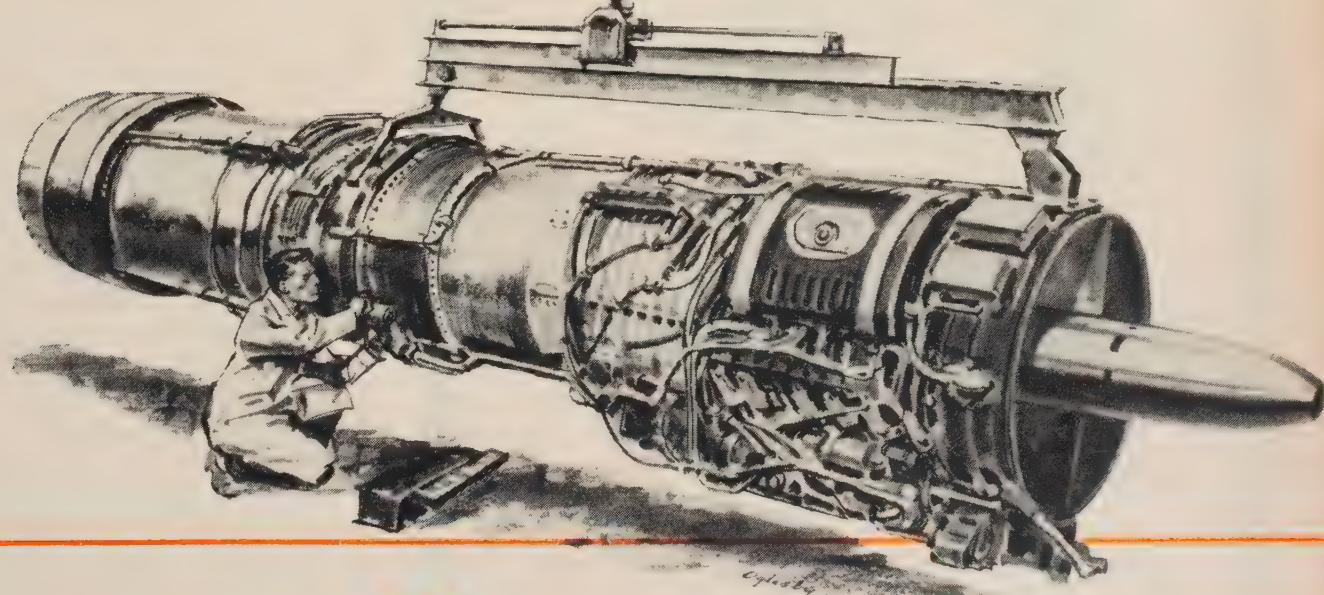
K19066



RG1231



H33



**Kaylock**  
ALL METAL SELF-LOCKING NUTS®



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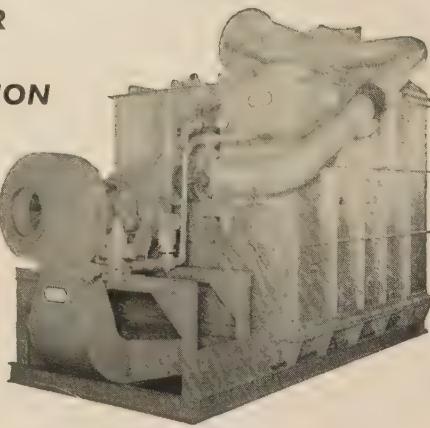
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## *Thermo* INDIRECT AIR HEATERS



Single unit package design with built-in efficiency for firing all types of oil and gas fuels. Completely automatic, trouble-free performance . . . small initial cost . . . low operation costs . . . compact . . . low maintenance! Also made as Direct Fired Heaters.

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Yesterday's limitations on logic design are broken through today. Our capabilities in this field contribute to the advanced design of the airborne computers used in our Inertial Guidance systems. If the new parameters in logic design challenge you, perhaps you'd like to work with us. Write to Mr. C. T. Petrie.



LITTON INDUSTRIES Electronic Equipment Division  
Beverly Hills, California

for operation and maintenance. Includes launchers, launch control, checkout, and damage control units, including consoles, equipment racks, electronic and mechanical equipment, and auxiliary supply systems; seaplane beaching vehicles, engine change and armament loading boats, special dollies, slings and cranes; portable, mobile, or fixed test equipment for pre-flight testing, fault localization, and depot maintenance; portable shelters, radioactive isotope handling, refueling buoys, mobile engine noise suppressors.

- GSE CONTRACTS — GSE for Mace, PSM, P6M and Vanguard research vehicle. Portions of GSE for Titan and Pershing.

- GSE LITERATURE—P5M ASW Support Facilities (No. 835 on Card); Support Equipment for the Martin P6M (No. 836 on Card).

**McCORMICK SELPH ASSOC.**, Hollister Airport, Hollister, Cal.

- GSE SPECIALTIES — Explosive bolts, pressure cartridges, gas generators, high-pressure electric terminals, igniters, initiators and shunts.

- GSE CONTRACTS—Atlas, Titan, Discoverer, Sidewinder, Polaris, Juno, Jupiter and many more subcontracts.

- GSE LITERATURE — Explosive Ordnance Technical Data Book (No. 837 on Card).

**MINNEAPOLIS-HONEYWELL REGULATOR CO.**, 2600 Ridgway Rd., Minneapolis 13, Minn.

- GSE SPECIALTIES — Automatic and manual test and checkout facilities as well as R & D and special test equipment for all types of weapon systems (nuclear, missile, aircraft) for functional and diagnostic readiness, reliability and maintenance testing. Study and research services for systems and operations analysis.

- GSE CONTRACTS — shipboard and shore based facilities for Asroc; AF: MB-5 automatic aircraft flight control and guidance checkout equipment for F-101B; AEC: automatic controller and reactor radiation monitoring on a plutonium recycle test reactor.

- GSE LITERATURE — Systems Support Equipment (No. 838 on Card); The Adaptive Systems Analyzer (No. 839 on Card); Random Access Programming Checkout Equipment RAP-COE (No. 840 on Card).

**MOOG SERVOCONTROLS, INC.**, Pruner Airport, East Aurora, N.Y.

- GSE SPECIALTIES — Electronic and hydraulic test equipment for checking performance of electrohydraulic servovalves and servoactuators used in control systems.

- GSE CONTRACTS—Convair: production items for F-102A and F-106A GSE.

**GEORGE L. NANKERVIS CO.**, 15300 Fullerton Ave., Detroit 27, Mich.

- GSE SPECIALTIES—missile test and support equipment for hydraulic, electronic and pneumatic systems.

- GSE CONTRACTS — Chrysler Missile: fluid filtration carts for Jupiter; Aerojet-General: portable hydraulic test cart.

- GSE LITERATURE — Hydraulic Test Cart (No. 841 on Card); Hydraulic

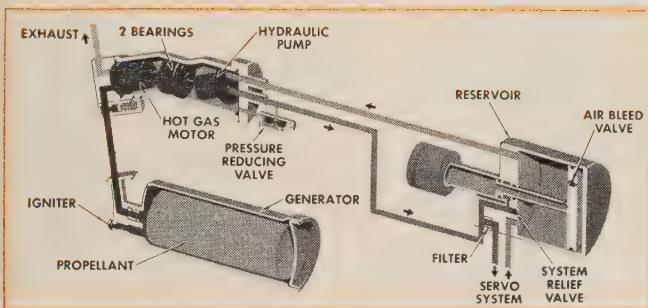
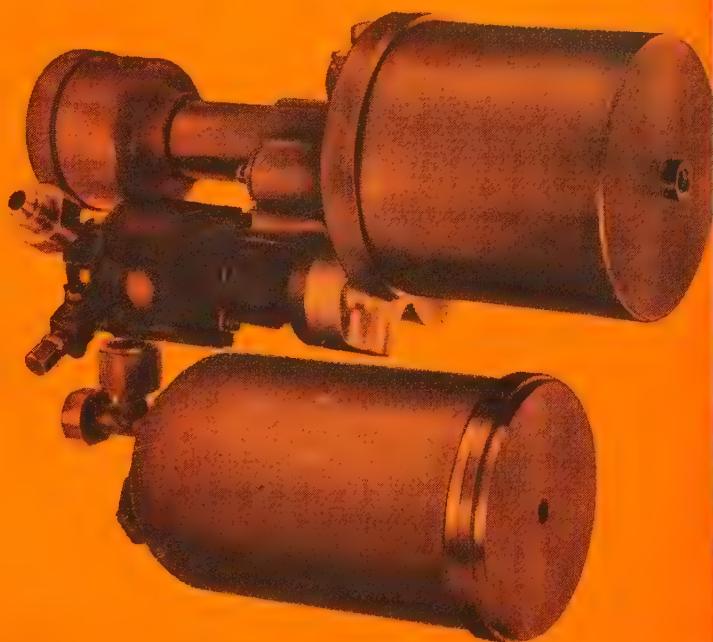
more on page 135

# FLIGHT HARDWARE...NOW

## VICKERS HOT GAS AUXILIARY POWER SYSTEMS for missiles and spacecraft

### CONCEPT

Vickers piston motors — as used in virtually all existing commercial and military aircraft — are now modified to operate efficiently on propellant-generated hot gas, or bleed gas from the main propulsion system. Minimum weight is achieved by mounting the hot gas motor "shaft-to-shaft" with a Vickers piston hydraulic pump in a common housing. The motorpump, a simple gas generator, hydraulic reservoir, filter, and relief valve are integrally mounted to form a complete Auxiliary Power System in a compact package.



### DEVELOPMENT

Production line Vickers hydraulic motors have been operating on hot gas for over 2 years. Units have run on gases as hot as 2300°F without modification.

The present flight hardware was built and tested after an intensive prototype development effort. Test program motorpumps have accumulated over 100 runs each for 1 minute of operation cycle. Since the current development program is aimed at meeting known APS requirements, no limits have been established on the operating cycle duration for this type of equipment.

### CONCLUSIONS

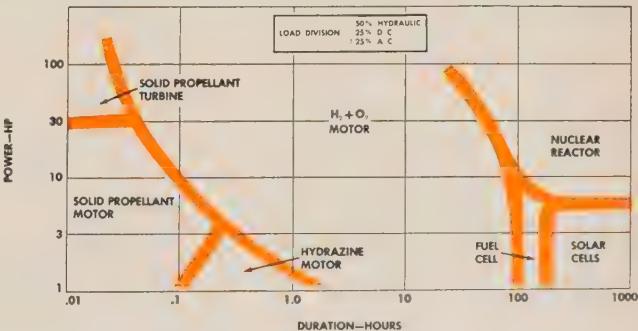
Performance and reliability goals for this concept have been met successfully. A complete hot gas APS package in the 2 - 8 horsepower range, shown above, is available within 90 days. Customer specifications for these and larger systems are invited. Write for Bulletin A-5223B.

### APPLICATIONS

Because of the increasing scope of APS applications, Vickers conducted a series of studies to establish criteria for APS selection. Recent study results (published in March, 1959) indicate that for short duration operation, hot gas motors offer the best weight advantage in the 1 to 30 hp range. See curve below.

Attractive reliability and early delivery resulting from extensive use of proven hardware may extend the application of these systems to an even greater range of second and third generation missiles and spacecraft. Additional advantages include: low speed equipment (up to 10,000 rpm), convenient ground checkout, growth potential, and no alert time required.

### OPTIMUM WEIGHT NON-PROPELLANT POWER SYSTEMS



AERO HYDRAULICS DIVISION  
**VICKERS INCORPORATED**  
DETROIT 32, MICHIGAN

division of:  
**SPERRY RAND CORPORATION**



SEALED RELAYS—unmatched for reliability



## All the dust in this room could hide under this dot



This is General Electric's "white room," where special, ultra-reliable miniaturized relays are painstakingly adjusted, inspected, and tested. On certain super-critical applications, particularly those involving dry-circuit switching, a tiny speck of dust could cause a sealed relay to malfunction, possibly resulting in failure of an entire electronic system.

To prevent such costly failures, General Electric has installed this special "white room" where elaborate precautions are taken to maintain a dust-free atmosphere for assembly of ultra-reliable sealed relays. Regular checks

insure that dust in the air does not exceed 20,000 particles per cubic foot. Compare this with well over a million particles per cubic foot in the average home or office.

But this dust-free assembly room is only part of General Electric's reliability story. Design leadership, such as produced the Unimite—world's smallest one-amp relay—and advanced manufacturing techniques—including a new inert-arc welding process to eliminate contact-contaminating solder and flux—consistently produce superior relays. Then, General Electric conducts ex-

haustive operational and environmental tests to prove extreme reliability.

Relay applications differ widely in performance requirements. Whatever your application, General Electric can offer sealed relays designed, built and tested to comply with your requirements. Call your G-E Apparatus Sales Engineer today or mail the coupon at right. General Electric Co., Specialty Control Dept., Waynesboro, Va.

*Progress Is Our Most Important Product*

**GENERAL ELECTRIC**

Write in No. 104 on Reader Service Card at start of Product Preview Section

## CAPABILITIES

Components Test Console (No. 843 on Card); Fluid Filtration Cart Bulletin (No. 844 on Card); Missile Test & Support Equipment (No. 845 on Card); General Test Equipment (No. 846 on Card).

**NON-LINEAR SYSTEMS, INC.**, Del Mar Airport, Del Mar, Cal.

- GSE SPECIALTIES—Subsystems such as automatic data logging systems for measuring, limit detecting and recording any electrical data or physical data transformed to electrical signals. GSE systems instruments such as digital voltmeters, ratemeters and ohmmeters; go/no-go voltage and resistance comparators; digital readouts; automatic input scanners; and semi-automatic data reduction equipment for oscilloscopes.

- GSE CONTRACTS — instruments to Martin, Northrop, Nortronics, Lockheed, Hughes, Western Electric, Redstone Arsenal, Boeing, General Electric, Convair, Arma, Sperry, RCA, etc.

- GSE LITERATURE — Automatic Testing Systems (No. 847 on Card); Transistorized Digital Volt-OHM-Ratios (No. 848 on Card); Oscillogram Trace Reader and Computer (No. 849 on Card); Voltage Comparator (No. 850 on Card).

**NORMANDY ELECTRIC WIRE CORP.**, 125 Second St., Brooklyn 31, N.Y.

- GSE SPECIALTIES—Launch pad cables; ground power cable; shielded portable cables for elimination of outside interference; heat and flame resistant control cable; impervious sheath and shielded cables.

- GSE CONTRACTS—GE, Westinghouse, Sperry, Redstone, and Cape Canaveral: electrical cables for launching, tracking, control and power distribution.

- GSE LITERATURE — Catalog (No. 851 on Card).

**NORTHROP CORP.**, 1001 E. Broadway, Hawthorne, Cal.

- GSE SPECIALTIES — General weapon systems support equipment.

- GSE CONTRACTS—AF: GSE for T-38A and SM-62A.

**NUCLEAR INSTRUMENTS DIV., TELECOMPUTING CORP.**, 12838 Saticoy St., N. Hollywood, Cal.

- GSE SPECIALTIES—for nuclear warhead systems. Manufacturing nuclear warhead testing equipment such as pre-programmed automatic checkout equipment, pre-programmed automatic instrumentation control, specialized "go-no-go" testers, and qualitative test equipment.

- GSE CONTRACTS—Nuclear test equipment for Honest John; Army: fully automated nuclear warhead testers.

- GSE LITERATURE—Engineering Services Brochure (No. 852 on Card).

**OWEN LABORATORIES, INC.**, 55 Beacon Place, Pasadena, Cal.

- GSE SPECIALTIES—Highly regulated, DC power supplies, strain gage control equipment, transistor test equipment, multi-channel transducer scanning and recording systems.

- GSE CONTRACTS—Hound Dog: primary high-current regulated power supply and precision voltage standards;

Nortronics: precision voltage standards and regulated general purpose supplies; Titan: transducer control equipment for checkout.

- GSE LITERATURE — Transducer Power Supply (No. 854 on Card); Indicator Panel & Bridge Balance (No. 855 on Card); Power Supply (No. 856 on Card); Bridge Controls & Indicator Panel (No. 857 on Card); Precision Power Supply (No. 858 on Card); Power Supplies (No. 859 on Card); Transistor Test Set (No. 860 on Card).

**PACKARD BELL ELECTRONICS**, 12333 W. Olympic Blvd., Los Angeles 64, Cal.

- GSE SPECIALTIES—Missile pre-launch electronic checkout; automatic solid-state checkout systems; analog-digital converters and digital building blocks; pre-flight radiation test set.

- GSE CONTRACTS — Thor; Polaris (Acre/Octopus and Digitizer); Talos tester (target detection device); C-N-1 test set.

- GSE LITERATURE—TD103 Solid State Automatic Checkout Systems (No. 861 on Card); TD 108 Pre-flight Test Set for C-N-1 (No. 862 on Card); ATC Transponder Ramp Test Set (No. 863 on Card); TD113 Test Set Equipment (No. 864 on Card).

**THE RALPH M. PARSONS CO., ELECTRONICS DIV.**, 151 De Lacey Ave., Pasadena, Cal.

- GSE SPECIALTIES — Electronics GSE for missile and aircraft.

- GSE CONTRACT—ABMA: working area and supporting office and lab space complete with equipment and instrumentation for check-out, including alignment, circuitry and control systems of complete missiles. Specialized test equipment and instrumentation systems for complete dry-run tests of missile guidance, control, pneumatic, hydraulic, electrical power, and measuring and telemetering systems.

- GSE LITERATURE — Engineering Capabilities (No. 865 on Card).

**PNEU-HYDRO VALVE CORP.**, 52 Horse Hill Rd., Cedar Knolls, N.J.

- GSE SPECIALTIES — Control valves for high and low temperatures, high pressures and corrosive or hard-to-contain fluids applications. Hydraulic and pneumatic systems and subsystems for ground support installations.

- GSE CONTRACTS — Air Force high pressure pneumatic reducing valves and manual shut-off valves; Navy: remote control high pressure ball valves; Army: remote control high pressure ball valves.

- GSE LITERATURE — Pneu-Hydro Valve Brochure (No. 867 on Card).

**POLARAD ELECTRONICS CORP.**, 43-20 34th St., Long Island City 1, N.Y.

- GSE SPECIALTIES — complex electronic, electromechanical and electropneumatic test equipment. Greatest ability in radio frequency and microwave calibrated FM-AM-pulse standard signal generators, receivers, antennae, transponders, servo balancing and exercising equipment, spectrum analysis, beacon test and generation guidance, pneumatic transducer calibration, setting and checkout, including precision pulse generation, modulation and detection.

- GSE CONTRACTS — Missile

*more on page 136*

G-E miniature, sub-miniature, micro-miniature and Unimite relays combine small size with unusual reliability under severe temperature, shock and vibration conditions to make them ideal for electronic jobs, both military and commercial. G-E's complete line of sealed relays includes these basic types:

**MINIATURE:** Long-life type; rated 5 amps at 28 volts d-c; in 2- or 4-pole double throw and 6PN0 forms. Ideal for ground applications.

**SUB-MINIATURE:** 2 amps at 28 volts d-c, 115 volts a-c, double-pole double-throw. Excellent thermal life.

**MICRO-MINIATURE:** Crystal-can type, double-pole and new welded 4-pole units. Rated 2 amps, 28 v d-c or 115 v a-c. Grid-space terminals available.

**UNIMITE:** The world's smallest 1-amp sealed relay; single-pole type. Isolated contact chamber, high speed 1.5 millisecond operation.

General Electric Co.

Section B792-14

Schenectady 5, N. Y.

Please send me a free copy of the 1959-60 Sealed Relay Catalog.

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**GENERAL ELECTRIC**

Write in No. 104 on Reader Service Card

October 1959

# ANNOUNCING

## A NEW TENSILE TESTER FOR WIRE TERMINALS

ACCURATE  
FAST  
COMPACT  
LOW COST  
PORTABLE



THE HUNTER MODEL "TT" TERMINAL PULL TESTER



The Hunter Model "TT" Tester is ideal for testing wire cable assemblies under MIL-T-7928 (ASG).

To expedite receipt of detailed literature on the Model "TT", write direct to Quality Control Department.

The "TT" Tester—latest addition to Hunter's growing line of quality control equipment—brings laboratory accuracy to production-line testing ( $\pm 0.5\%$  of full-scale reading). Though you'll find it adaptable to many other tensile tests in ranges up to 0-500 pounds, its special job is checking the secureness of solderless terminals crimped on wire. Automatically opening and closing jaws grip the wire sample; a turret-type gage head indexes quickly to hold any size terminal; load is applied at a preset rate by an adjustable air cylinder; and breaking load registers and is held on a direct-reading dial until reset by a touch of the quick-reset tab. Over-all speed of testing is up to ten times faster than by conventional methods.

Whether you attach terminals in your plant, or are supplied with wire assemblies — whether you use it in the plant or the laboratory—the "TT" Tester will help you establish useful standards and control quality by sample testing.

### HUNTER SPRING COMPANY

A Division of American Machine and Metals, Inc.

7 Spring Avenue, Lansdale, Pennsylvania

SPRINGS • STAMPINGS • QUALITY CONTROL EQUIPMENT

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156



### CAPABILITIES

checkout equipment and ECM checkout equipment (classified). Subcontracts on Atlas, Lacrosse, Mace, Matador, Nike-Zeus, Vanguard and B-58.

• GSE LITERATURE — Digital Computing Techniques (No. 868 on Card); Field Intensity Measuring Set (No. 869 on Card); Test Equipment (No. 871 on Card).

RADIATION, INC., INSTRUMENTATION DIV., 5800 McCoy Rd., Box 2040, Pinecastle Branch, Orlando, Fla.

• GSE SPECIALTIES — electronic test and checkout facilities for R & D and operational weapon systems from specialized bench type test sets to complete system support facilities including automatic, high speed, system checkout and maintenance analysis.

• GSE CONTRACTS — AF: AN/UPM-19C test set for radar transponder beacons; AF: complete ground support of airborne ECM system.

• GSE LITERATURE — Semi-Automatic Analog Test Set (No. 872 on Card); High Speed Automatic Digital Test System (No. 873 on Card); Specialized Analysis and Checkout Equipment (No. 874 on Card); Digital Test and Analysis System (No. 875 on Card).

REMINGTON RAND UNIVAC DIV., SPERRY RAND CORP., Univac Park, St. Paul 16, Minn.

• GSE SPECIALTIES — electronic digital computing equipment such as UNIVAC M-460 computer used in testing Bomarc.

• GSE LITERATURE — Systems Management (No. 876 on Card); Reliability (No. 877 on Card); Environmental Testing Facilities (No. 878 on Card); Military Engineering Division (No. 879 on Card).

REPUBLIC MANUFACTURING CO., 15655 Brookpark Rd., Cleveland 35, Ohio

• GSE SPECIALTIES — Valves for hydraulics, pneumatics, and special services (plug, relief, check, zero leakage selector, globe, needle, pressure snubber, and fuel control units).

• GSE LITERATURE — General Catalog (No. 880 on Card).

RESE ENGINEERING, INC., 731 Arch St., Philadelphia 6, Pa.

• GSE SPECIALTIES — Random access stores and buffers for storage of control display and sequencing information; logic blocks for implementing special control sequencing and timing functions; design of special purpose digital data processors; continuous monitoring and spot-check ground support equipment including memory exercisers, mag-amp testers, etc.

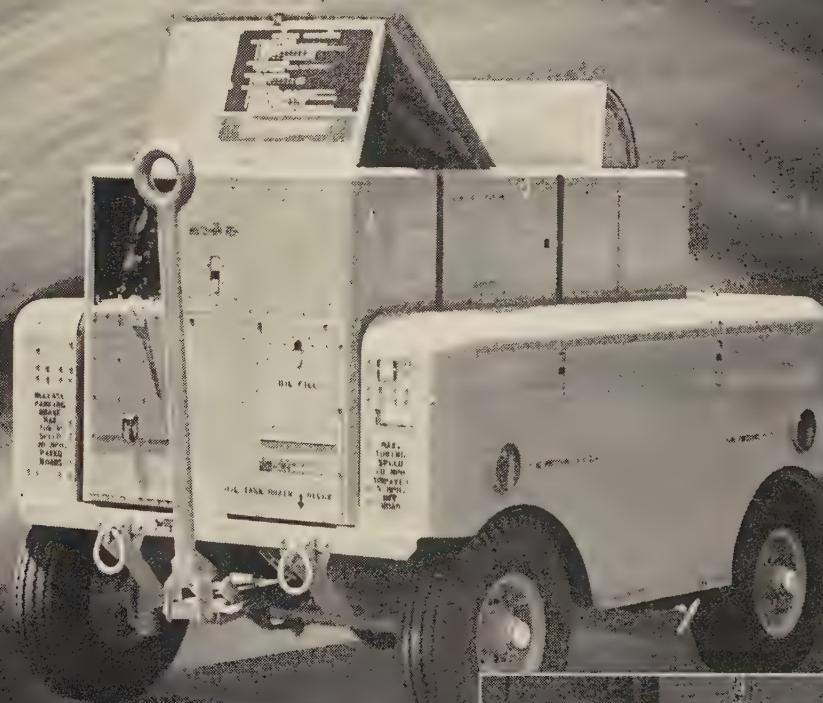
• GSE LITERATURE — Engineering Facilities (No. 881 on Card); Flux Reset Core Tester (No. 882 on Card); Current Pulse Generator (No. 883 on Card); Programmed Current Pulse Generator (No. 884 on Card); Magnetic Core Tester (No. 885 on Card); React Automatic Core Tester (No. 886 on Card); "Logis" Blocks (No. 887 on Card); Store System Exerciser (No. 888 on Card); Random Access Store (No. 889 on Card).

RESEARCH, INC., 115 N. Buchanan, Hopkins, Minn.

• GSE SPECIALTIES — Complete more on page 138

SPACE/AERONAUTICS

# AiResearch gas turbine Completes 5,000 start cycles



**Reliability Record  
Achieved Under Tough  
Test Conditions**



Air Force trailer-mounted MA-1A starter cart with improved  
AiResearch GTC 85-20 gas turbine unit.

AiResearch engineers inspecting improved AiResearch GTC 85-20  
gas turbine unit after successful 5,000 start cycle test.

A world performance record for small gas turbine reliability has been established by this improved AiResearch GTC 85-20 unit... 5,000 start cycles. During each start cycle the turbine was brought to peak load twice, with a shut down time of only five minutes. This is equivalent to two main engine starts per cycle.

Throughout the entire test only routine maintenance was necessary plus

replacement of one generator brush. AiResearch gas turbines now in production incorporate the improvements made in this newly tested unit.

Pneumatic power source for the Air Force's trailer-mounted MA-1A starter cart, the engine was torn down under supervision of Air Force personnel from Wright Air Development Center. It is now undergoing further tests upwards of 10,000 start cycles.

This intense product improvement in gas turbine reliability is matched only by AiResearch versatility. The world's largest manufacturer of lightweight turbomachinery, AiResearch has designed, developed and produced more than 8,500 gas turbines of all types vital to military and commercial ground support as well as auxiliary and prime power applications. Your inquiries are invited.

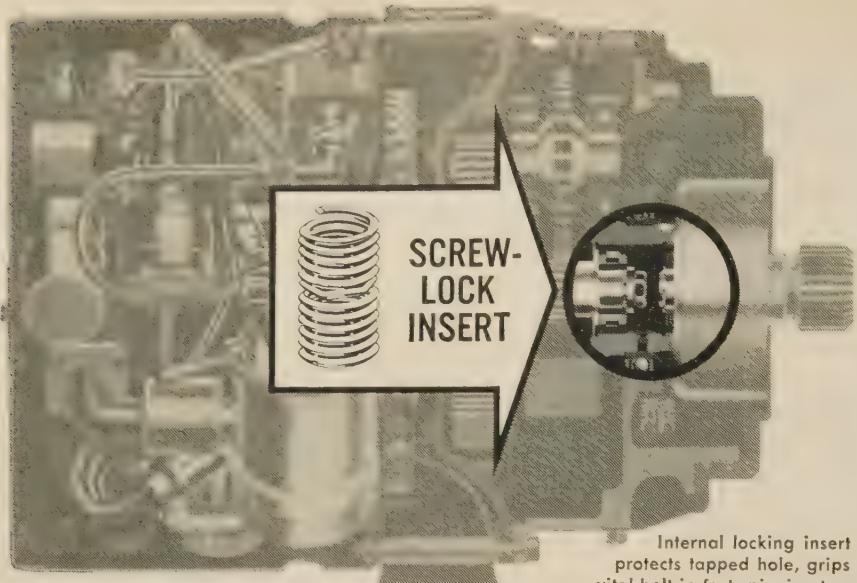


## AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

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at 46,000 R.P.M.

**HELI-COIL**®

### SCREW-LOCK INSERT\*

holds this vital bolt fast  
...Without Lock Washers  
or Lock Wiring!

Even when the turbine shaft of General Electric's new AS-18 turbostarter whirs at 46,000 rpm... the key bolt at the end of the shaft can't work or wear loose. General Electric puts a one-piece, *internal locking Heli-Coil Screw-Lock Insert* in this tapped hole, gets thread security in this important threaded assembly despite vibration met at high shaft speeds. In addition to the critical shaft application, General Electric uses more than 40 of these *Heli-Coil* stainless steel wire inserts throughout this compact 165 hp starter for aircraft gas turbines. Production and performance benefits? Unshakeable fastener security *without* the use of clumsy, heavy lock nuts, lock washers and lock wiring... lighter weight... less installation cost... faster and easier assembly and disassembly of this tiny power pack that weighs only 46 pounds! \*Patented

#### Heli-Coil Screw-Lock Inserts

- positively lock screws and bolts against loosening under impact and vibration
- prevent thread wear, stripping, corrosion, galling and seizing
- eliminate lock nuts, lock wiring, other supplementary locking devices
- can be used in standard proportion bosses without need for redesign
- are available in a complete range of U.N.C. and U.N.F. thread sizes
- save assembly time, space, weight and cost
- meet military specs for locking torque and vibration



**HELI-COIL CORPORATION**  
DANBURY, CONNECTICUT

**HELI-COIL CORPORATION, 110 Shelter Rock Lane, Danbury, Connecticut**

Send complete design data on Heli-Coil Screw-Lock Inserts

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FIRM \_\_\_\_\_

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CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_

heating systems equipment for automatically programming, recording and controlling of equipment or processes; specialized electrical, mechanical or electromechanical components; displacement transducers and accelerometers.

• GSE CONTRACTS — Lockheed Missle Systems: complete elevated temperature system including temperature programmers, power controllers and heaters; General Electric-Endale: displacement transducers for high temperature environment; Jet Propulsion Lab: statistical recording accelerometers.

• GSE LITERATURE — Elevated Temperature Equipment (No. 890 on Card); Data-Trak Design (No. 891 on Card); Load Programming (No. 892 on Card); Deflection Transducer (No. 893 on Card) Accelerometers (No. 894 on Card); Prekorder Data Sheet (No. 895 on Card).

**RESISTOFLEX CORP.**, Roseland, N.J.

• GSE SPECIALTIES—Fluoroflex-hose assemblies for hydraulic, pneumatic, fuel and oxidizer GSE applications.

• GSE CONTRACTS—Subcontract for systems such as Hawk B-58 and Talos.

• GSE LITERATURE — Aircraft Handbook (No. 896 on Card). Fluoroflex-T Chemical Transfer Hose (No. 897 on Card).

**ROCKETDYNE**, 6633 Canoga Ave., Canoga Park, Cal.

• GSE SPECIALTIES — Ground equipment for liquid propellant rocket engines ranging from 1,000 to 1,500,000 pounds in thrust for launch control and monitoring; servicing; test and maintenance; handling, transport, and storage and training.

• GSE CONTRACTS—GSE for engines in Atlas, Thor, Jupiter and Redstone and for space vehicle applications.

**RONAN & KUNZL, INC.**, 502 Kalamazoo Ave., Marshall, Mich.

• GSE SPECIALTIES—liquid oxygen and nitrogen handling equipment.

• GSE CONTRACTS—50 gallon liquid storage and transport containers for servicing aircraft; spare parts for liquid oxygen containers.

• GSE LITERATURE — General Catalog (No. 898 on Card); 50 Gallon LOX Container (No. 899 on Card); 500 Gallon LOX Container (No. 900 on Card); Truck Mounted Cryotainer (No. 901 on Card); 500 Gallon Cryotainer for Storage and Transport (No. 902 on Card); 1000 Gallon Cryotainer for Storage and Transport (No. 903 on Card).

**SANBORN CO.**, 175 Wyman St., Waltham 54, Mass.

• GSE SPECIALTIES — Oscillographic recording systems with related amplifiers.

• GSE LITERATURE — System Folder (No. 905 on Card).

**SONOTONE CORP., BATTERY DIV.**  
Elmsford, N.Y.

• GSE SPECIALTIES — Sintered plate nickel cadmium batteries.

• GSE CONTRACTS—Solar batteries to start gas turbine engine on the KC-135 aircraft; Garrett-Phoenix: batteries to start turbine engine for MA-1-A ground power cart; Cemco Industries batteries

more on page 148

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SPACE/AERONAUTICS

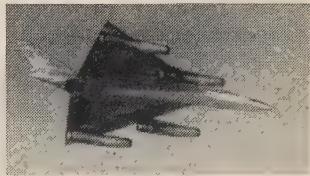


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**A N A L Y Z E R**

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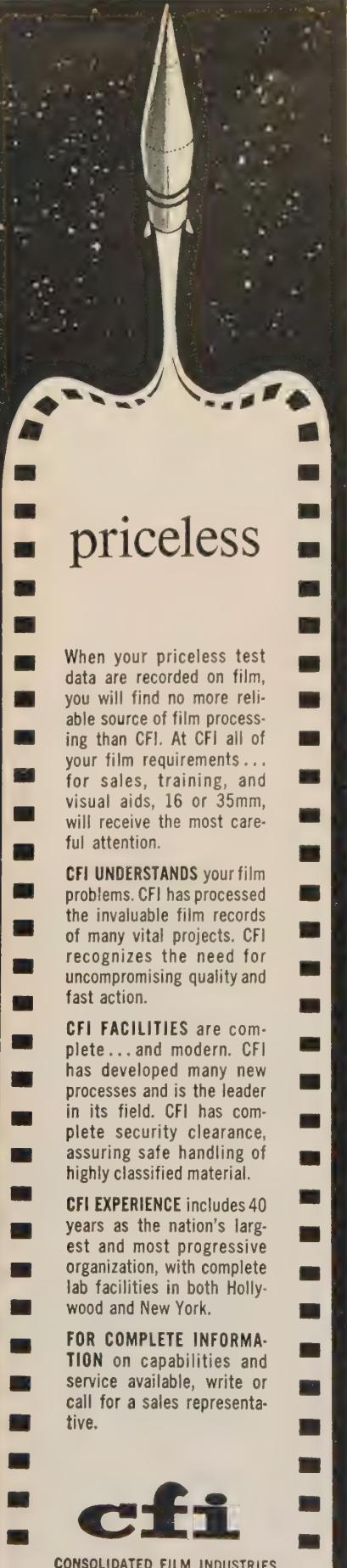
TESTS EGT SYSTEM ACCURACY to  $\pm 4^\circ\text{C}$   
(functionally, without running the engines).  
RUNS TEMPERATURE SPREAD CHECK on TWO ENGINES  
at SAME TIME. CUTS TEST TIME 50%.  
TESTS RPM ACCURACY to 10 RPM in 10,000 RPM ( $\pm 0.1\%$ ).  
CHECKS HEAT, ANTI-ICE and FIRE DETECTION SYSTEMS.

**B & H INSTRUMENT CO., INC.**  
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ATLANTA, GA., COMPTON, CALIF., DAYTON, OHIO, VALLEY STREAM, L.I., N.Y.  
WICHITA, KAN., TORONTO, ONT. (George Kelk Ltd.),  
MITCHAM, SURREY, ENGLAND (Bryans Aeroequipment Ltd., Exclusive  
licensee and manufacturer for Great Britain, British Commonwealth and Europe)

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When your priceless test data are recorded on film, you will find no more reliable source of film processing than CFI. At CFI all of your film requirements... for sales, training, and visual aids, 16 or 35mm, will receive the most careful attention.

**CFI UNDERSTANDS** your film problems. CFI has processed the invaluable film records of many vital projects. CFI recognizes the need for uncompromising quality and fast action.

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**CFI EXPERIENCE** includes 40 years as the nation's largest and most progressive organization, with complete lab facilities in both Hollywood and New York.

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## CAPABILITIES

for MB-3 ground deicing and decontaminating unit.

- **GSE LITERATURE** — General Catalog (No. 906 on Card).

### SPERRY MICROWAVE ELECTRONICS CO., Clearwater, Fla.

- **GSE SPECIALTIES** — semi-automatic and automatic checkout equipment.

• **GSE CONTRACTS** — AF automatic checkout for B-58 bombing-navigation system. AF R&D on support equipment for airborne IFF systems. Shipboard support equipment for Talos guidance radar.

- **GSE LITERATURE** — RACE Brochure (No. 907 on Card).

### STAVID ENGINEERING, INC., U.S. Highway No. 22, Plainfield, N.J.

- **GSE SPECIALTIES** — missile launch control systems (instrumentation); telemetry facilities; simulators.

• **GSE CONTRACTS** — Edwards AFB integrated instrumentation system for acquisition, transmission, monitoring and recording of data for Silo launch system (Minuteman). Edwards AFB: instrumentation of Silo launch control. BuShips: dynamic testers and simulators for missile guidance system AN/BPQ-2 (Regulus I).

- **GSE LITERATURE** — Company Brochure (No. 908 on Card); Field Operations (No. 909 on Card).

### STEARNS-ROGERS MFG. CO., 660 Bannock, Denver, Colo.

• **GSE SPECIALTIES** — liquid oxygen and liquid nitrogen transfer lines; liquid oxygen, nitrogen and hydrogen storage dewars; facilities for production, purification, and testing liquid hydrogen; liquid fluorine facilities and special liquid fluorine trailers; facilities for purification and recovery of gaseous and liquid helium; 5,000 psi gaseous nitrogen storage and transfer lines, and 10,000 psi gaseous helium storage and distribution systems; components for processing plants requiring 3,000 psi for operation. Mechanical and electrical equipment required for GSE, including cryogenic piping, high pressure piping, propellant loading systems, refrigeration systems, and all other mechanical and electrical equipment and controls.

• **GSE CONTRACTS** — Architectural-engineering services on SM-65 Warren AFB launch complexes, helium purification and reclamation system (AF); liquid fluorine dewars.

• **GSE LITERATURE** — Cryogenics, Nuclear Engineering, High Pressure Systems Brochures (No. 910 on Card); Pipe Fabrication Brochures (No. 911 on Card).

### SUN ELECTRIC CORP., Harlem & Avondale Aves., Chicago 31, Ill.

• **GSE SPECIALTIES** — Aircraft hydraulic systems test stands, hydraulic power sources for aircraft and missile systems electrical test equipment, load banks and power absorbers for aircraft and missile generators and alternators. Portable indicating and measuring instruments such as vibration analyzers, temperature control sensors, oxygen mask and headset testers, oscilloscopes

and engine analyzers, recording instruments, punched tape programmers and sequencers, high precision electrical indicating instruments.

• **GSE CONTRACTS** — Convair-San Diego: electrical power test set (load bank) for F-106; Convair-San Diego: hydraulic system test stand for F-106; Martin-Denver: hydraulic power source consoles for Titan.

• **GSE LITERATURE** — Test and Support Equipment Catalog (No. 912 on Card); Aeronautical Division Facilities Study (No. 913 on Card).

### THE TALLEY CORP., 101 Highway & Conejo Rd., Newbury Park, Cal.

• **GSE SPECIALTIES** — Electro-mechanical rotating equipment such as actuators, jackscrew devices, acme or ballscrew types, hoists, alternators, electric motors, gearboxes, electric driven hydraulic pump and alternator power units. Electromechanically and pneumatically driven hot or cooling air valves, LOX, nitrogen, helium and missile fuel valves. Umbilical connector valves.

• **GSE CONTRACTS** — AF: linear actuator used in hydraulic valve positioner for Thor; Martin-Orlando: electric hoist for Pershing; Martin-Orlando: tachometer-generator for Lacrosse.

• **GSE LITERATURE** — Talley Facilities Brochure (No. 914 on Card); Talley List of Products (No. 915 on Card); The Talley Electric Motor Story (No. 916 on Card).

### TELECOMPUTING SERVICES, 8949 Reseda Blvd., Northridge, Cal.

• **GSE SPECIALTIES** — data processing.

• **GSE CONTRACTS** — Vandenberg AFB: SAC logistics and operations data processing.

• **GSE LITERATURE** — Engineering Services Brochure (No. 917 on Card).

### TEMCO AIRCRAFT CORP., Box 6191, Dallas, Tex.

• **GSE SPECIALTIES** — Develop logistics to determine in advance standard and special ground handling, test and checkout, simulation and tracking equipment, and shipping containers required during development and tactical phases of a weapon systems development program.

• **GSE CONTRACTS** — Corvus: maintenance test equipment includes all special electronic, hydraulic and pneumatic test equipment required to locate malfunctioning components of the weapon system; operational test and checkout equipment for system testing missile and launch aircraft; handling equipment.

• **GSE LITERATURE** — Temco Capabilities and Facilities (No. 918 on Card); Support Equipment (No. 919 on Card).

### THERMOID DIV., H. K. PORTER CO., INC., Trenton 6, N.J.

• **GSE SPECIALTIES** — Jet starter hose.

• **GSE CONTRACTS** — Warner more on page 142



# **FIRST RULE FOR DELEGATING GROUND SUPPORT EQUIPMENT RESPONSIBILITY: FIND AN AUTHORITY**

Through 70 years of war and peace, St. Louis Car has developed, tested and built transport and handling equipment... railroad stock... amphibious vehicles... aircraft... special-purpose carriers and mounts.

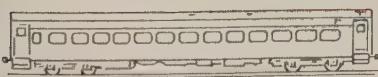
Use this experience when you need transport and handling equipment, engineered from the systems approach to meet the specific operational objectives of your weapon.

Before you assign any transport and handling equipment work—from R&D to production—evaluate St. Louis Car. We welcome the chance to submit proposals.

## **ST. LOUIS CAR COMPANY**

St. Louis 15, Mo.

Write on your letterhead for Information Kit SA-11.



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## New Deutsch "Snap-In" Miniature Connectors

make RELIABILITY a REALITY



Here's a snap-in miniature you can trust to do what it's supposed to do. The new Deutsch DS Series of quick-disconnect connectors—with insertable and removable contacts and crimp-type terminations—has been thoroughly tested and *proved* under extreme environmental conditions.

*proven*  
Check these advantages  
against your design requirements

	DS FEATURES	YOUR DESIGN REQUIREMENTS
1 Pins and sockets	Easily insertable and removable	
2 Terminations	Crimp-type	
3 Contact retention	Withstands minimum of 25 lbs. pull	
4 Crimp strength	Greater than the wire itself	
5 Hand tools	Simple, fool-proof crimping, inserting and removal tools	
6 Interfacial seal	Continuous dielectric separation without voids; no bonding, reversion or shrinkage of inserts	
7 Environmental	Meets or exceeds MIL-C-26482 (ASG)	
8 Temperature	-100°F. to 300°F.	
9 Push-pull coupling	Positive ball-lock design; operates in direction of plug travel	
10 Contact size	Immediately available in #20 size; others to follow	
11 Shell size	Immediately available in 3, 7, 12, 19, 27, 37 and 61 contacts	
12 Interchangeability	Mates with existing Deutsch DM5000, DM6500 and DM9000 series	
13 Assembly	Delivered completely assembled except for insertion of contacts	

For complete technical information and test report, contact your Deutsch Representative or write us for Data File 10.



**The Deutsch Company**  
7000 Avalon Boulevard • Los Angeles 3, Calif.

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## CAPABILITIES

Robins AFB: Jet starter hose, Memphis AFB: ground refueling hose.

- GSE LITERATURE — Jet Starter Hose Brochure (No. 920 on Card); Ground Refueling Hose Brochure (No. 921 on Card).

THIOKOL CHEMICAL CORP., REACTION MOTORS DIV., Denville, N.J.

- GSE SPECIALTIES — rocket checkout equipment and valves, pressure regulators, disconnects, pumps and systems of components for missile propellant transfer.

• GSE CONTRACTS — X-15: engine checkout console for pre- and post-flight checkout of the various engine hydraulic, pneumatic and electrical subsystems and malfunction circuits. Atlas: liquid oxygen—hydrocarbon fill and drain disconnects. Atlas: universal fluid coupling.

- GSE LITERATURE — Components Brochure (No. 922 on Card); Accomplishments and Capabilities (No. 923 on Card); Various Product Data sheets (No. 924 on Card).

THE THOMPSON - RAMO - WOOLDRIDGE PRODUCTS CO., 202 N. Canon Drive, Beverly Hills, Cal.

- GSE SPECIALTIES — Digital control computers, magnetic tape units, systems engineering for automatic checkout of missiles and aircraft.

• GSE LITERATURE — RW-300 Digital Control Computer (No. 925 on Card); The RW-300 Magnetic Tape Unit (No. 926 on Card).

TRAILMOBILE, INC., 31st & Robertson, Cincinnati 9, Ohio

- GSE SPECIALTIES — Missile shipping and storage containers.
- GSE CONTRACTS — Martin: containers for Lacrosse.

THE TRANE CO., La Crosse, Wis.

- GSE SPECIALTIES — air conditioning system components including reciprocating compressors, coils, fans and brazed aluminum for stationary and mobile units.

• GSE LITERATURE — Trane Compressor Catalog (No. 927 on Card); Trane Aluminum Compressor Catalog (No. 928 on Card); Trane Fan Catalog (No. 929 on Card); Trane Coil Catalog (No. 930 on Card); Trane Heat Transfer Catalog (No. 931 on Card).

UNITED AIRCRAFT PRODUCTS, INC., 1116 Bolander Ave., Dayton, Ohio

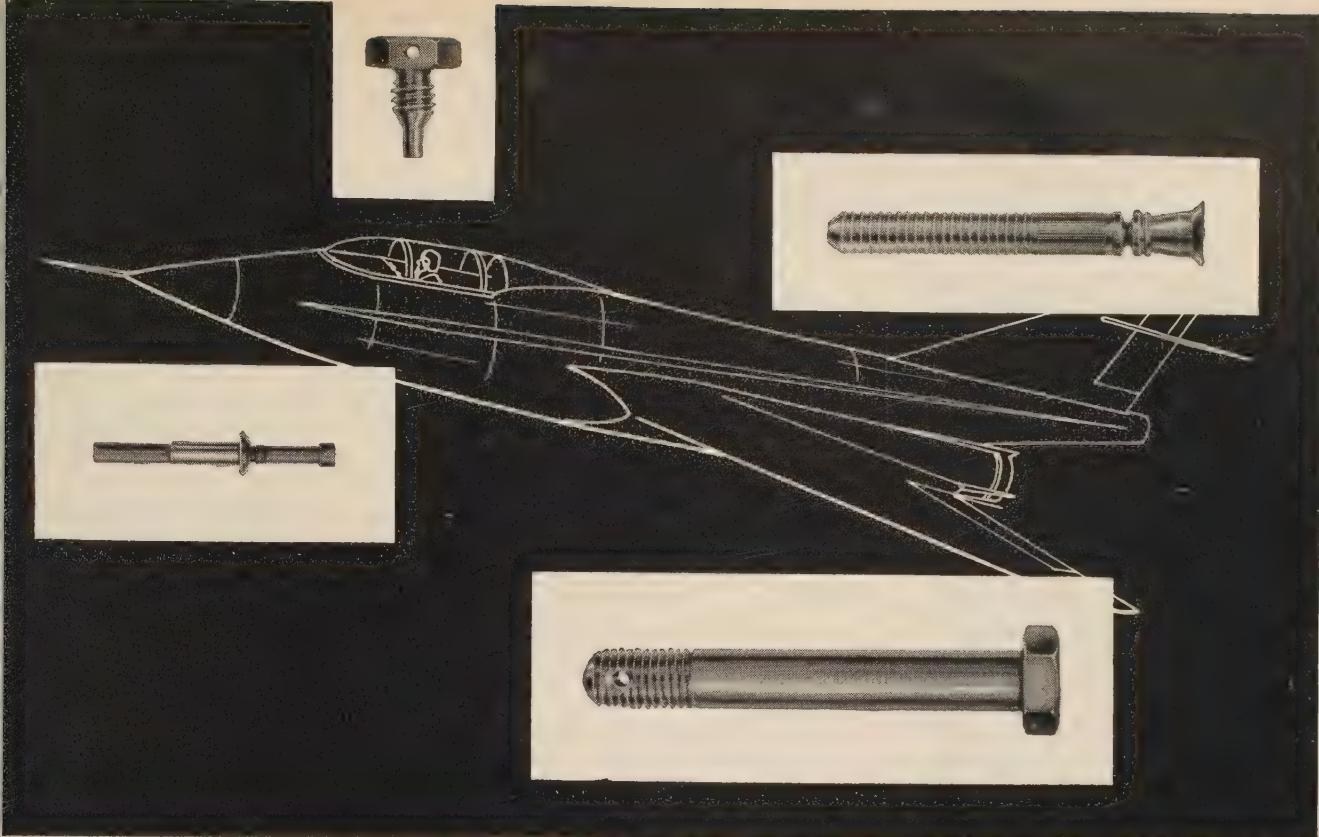
- GSE SPECIALTIES — Heat exchange systems and precise hydro- and electro-mechanical devices. GSE components and systems for propulsion units, fire control, navigation, photographic and armament equipment cooling.

• GSE CONTRACTS — Hawk: hydraulic console structure assembly and degreaser and accumulator console assembly; electronic equipment cooling oil/air heat exchanger, blower, thermal bypass valve, quick disconnect plumbing and chassis.

- GSE LITERATURE — Action at UAP (No. 932 on Card); Handbook—United Metallic O-Rings (No. 933 on Card).

more on page 144

SPACE/AERONAUTICS



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- GSE CONTRACTS — Propellant loading computer for Thor; angle-of-attack system analyzer for F-101; universal tester, or multipurpose instrument system to check out and troubleshoot temperature control systems for B-52.

- GSE LITERATURE — Facilities and Capabilities (No. 934 on Card); United Control Monthly Product News (No. 935 on Card).

**UNITED MANUFACTURING CO.**, 41 Haig St., Hamden 14, Conn.

- GSE SPECIALTIES — Electrical test equipment, fuel system test stands, air heating and cooling units, automatic test systems, and stands handling "exotic" fluids.

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- GSE CONTRACTS — Forbes AFB: missile pod dehumidification and cooling; Army: dehumidification of launching facilities; Army: controlled humidity storage of missiles and propellants.

- GSE LITERATURE — General Bulletin (No. 936 on Card).

**VAP-AIR DIV., VAPOR HEATING CORP.**, 6444 W. Howard St., Chicago 48, Ill.

- GSE SPECIALTIES — Temperature control equipment and systems; mercury thermostats; in-line air valves; electro-pneumatic valves; voltage regulators; relays; panel controls; pressure reducing valves; power controllers.

- GSE CONTRACTS — Components and systems on Titan, Redstone, Snark, etc.

- GSE LITERATURE — Vapor Merc Thermal Switches (No. 937 on Card); Surface Temperature Sensing Thermostats (No. 938 on Card); Air Temperature Sensing Thermostats (No. 939 on Card); Fabilite In-Line Valves (No. 940 on Card); Electro-Pneumatic Air Temperature Control System (No. 941 on Card); Liquid Temperature Sensing Thermostats (No. 942 on Card); Power Controllers (No. 943 on Card).

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- GSE LITERATURE — Speed Controls (No. 944 on Card); Precision Frequency Meters (No. 945 on Card); Ground Power Supply (No. 946 on Card).

**WASHINGTON TECHNOLOGICAL ASSOC., INC.**, 979 Rollins Ave., Rockville, Md.

- GSE SPECIALTIES — handling equipment, shipping containers, launchers, test and checkout equipment, and safety and automatic controls.

- GSE CONTRACTS — Talos automatic electro-hydraulic strikedown and mating system. Terrier-Tartar missile depot handling equipment and at-sea transfer system. Polaris shipping containers (design study and analysis).

- GSE LITERATURE — How to Handle A Guided Missile (No. 947 on Card).

**WHITTAKER CONTROLS DIV., TELECOMPUTING CORP.**, 915 N. Citrus Ave., Los Angeles 38, Cal.

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- GSE CONTRACTS — Westinghouse: record-playback system for Polaris to plot pressure transients in an X-Y plotter while digitizing the information.

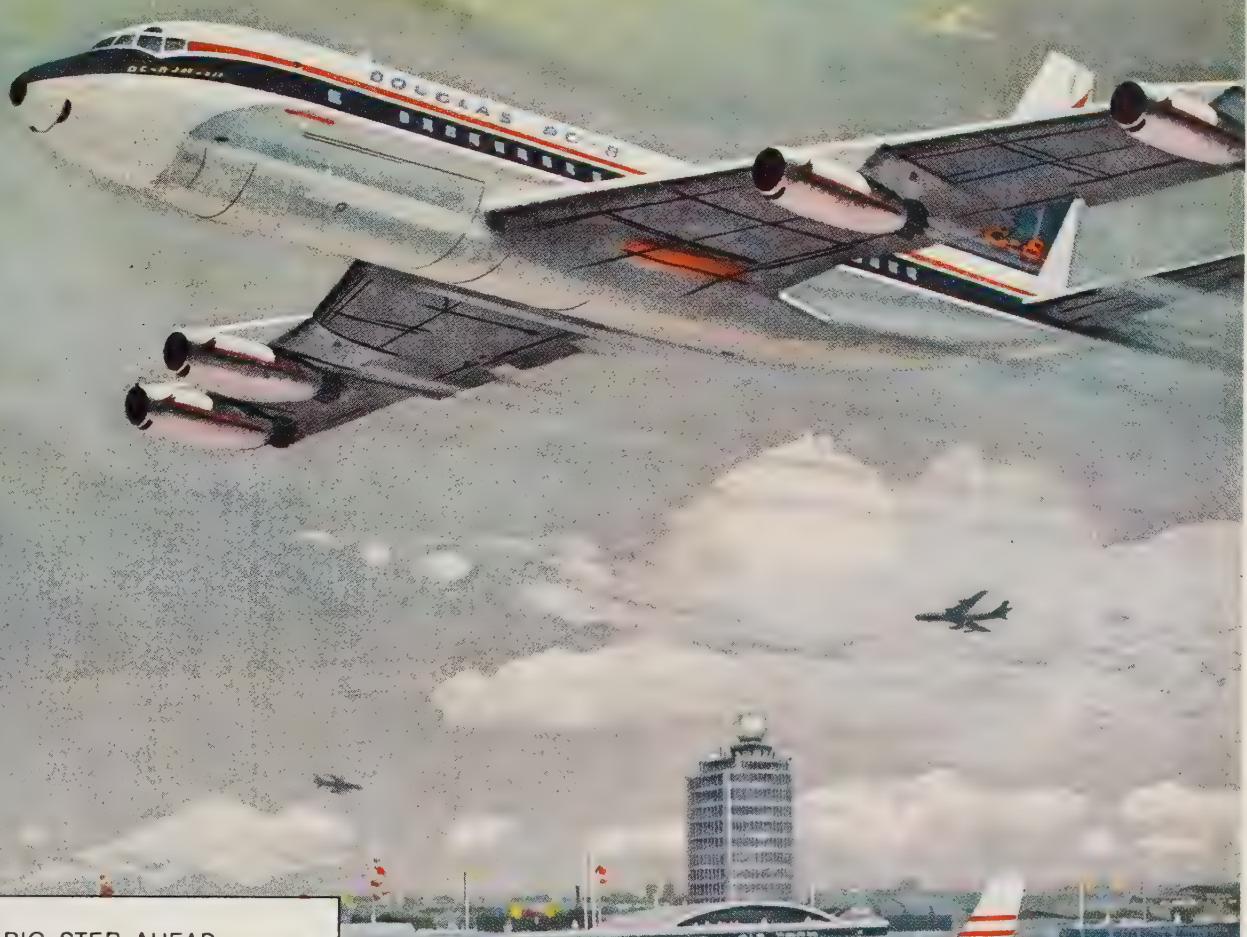
- GSE LITERATURE — Digital Ratio Systems (No. 949 on Card); Pressure Pickups for Extreme Acceleration and Vibration Environments (No. 950 on Card); Hi-Temperature Pressure Pickup (No. 951 on Card); DC Pressure Transducers (No. 952 on Card); Automatic Pressure Calibration System (No. 953 on Card); Company Facilities Brochure (No. 954 on Card).

**E. B. WIGGINS OIL TOOL CO., INC.**, 3424 E. Olympic Blvd., Los Angeles 23, Cal.

- GSE SPECIALTIES — Quick disconnects for topping lines, fill and drain systems, sensor lines, charging and chemical processing for missiles.

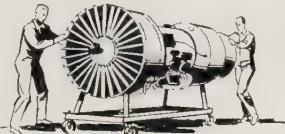
- GSE CONTRACTS — Polaris umbilical; Titan umbilicals; pneumatic start connects for topping lines, fill and drain connectors; Green Quail umbilical Atlas umbilical; Thor umbilical.

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## Accessory Systems

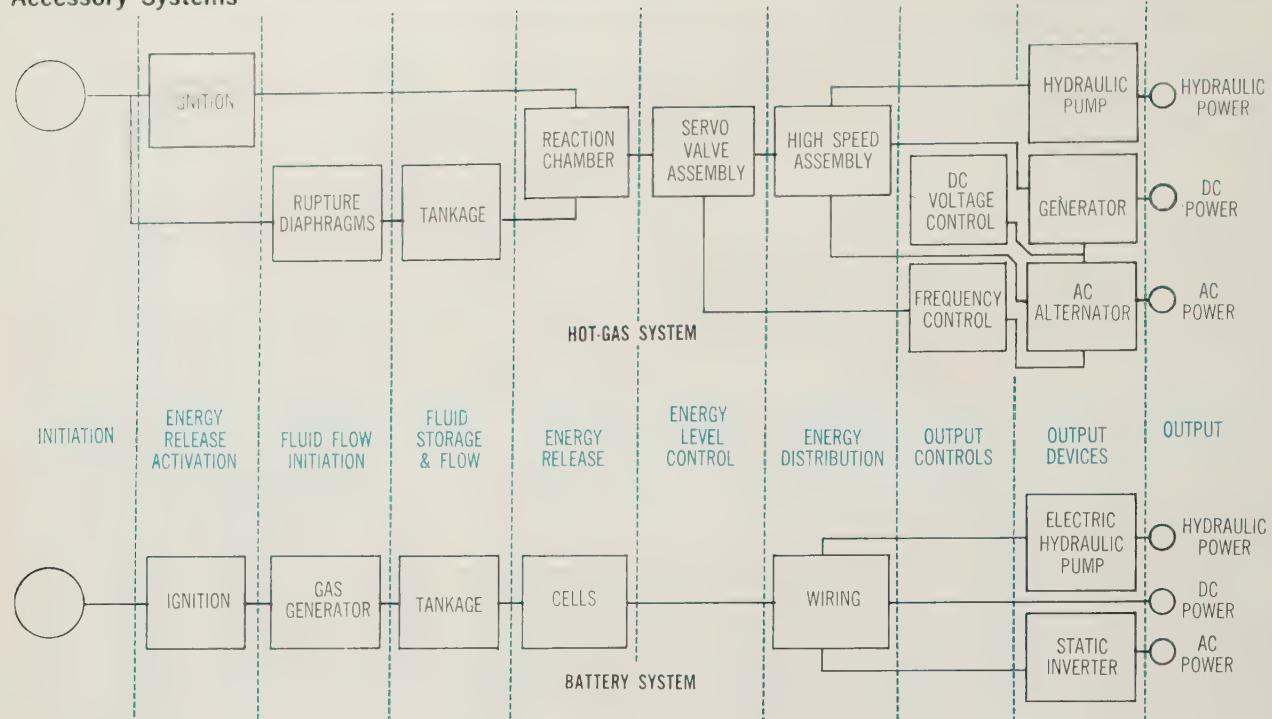


FIGURE 1: Greater simplicity is one of the main advantages claimed for batteries over hot-gas systems.

# Batteries challenge hot-gas systems for APU applications

In recent years, hot-gas turbines have had the edge over batteries as missile APU power sources. Today, this situation is being reversed by new and more efficient battery designs.

by W. A. Fischer and J. A. Sibilia,

Staff Engineer & Engineering Supervisor  
Cook Batteries Div., Telecomputing Corp.\*

**T**HE AUTOMATICALLY activated silver-zinc primary battery is successfully challenging hot-gas turbines for missile APU systems. In the past, weight and reliability problems prompted designers to go to hot gas turbines rather than batteries. Since then, however, marked progress has been made in developing highly reliable, high energy-to-weight battery units.

At the same time that batteries were being improved and simplified, increased APU needs caused hot-gas systems to become more and more complex (Fig. 1). Another major disadvantage of the hot-gas system is the requirement for specially trained maintenance crews at the launch site. Over 2000 spare parts are now re-

\* Cook Batteries Div., Telecomputing Corp., 3850 Olive St., Denver 7, Colo.

## Some Automatically Activated Cook Batteries

Model	Output (V)	Ampere-Hours & Rate	Size (in.)	Activation Time (sec)
P11A	28	4.2 @ 5 min	6 x 5.7 x 5.6	1
P30A	28	12.4 @ 6 min	11.5 x 7.75 x 5	0.7 <sup>1</sup>
P13A	56	7.5 @ 2.5 min	<sup>2</sup>	0.8 <sup>1</sup>

(1) Under load. (2) Takes up 146 deg of a ring 12.3 in. in OD, 4.6 in. in ID, and 10.9 in. long.

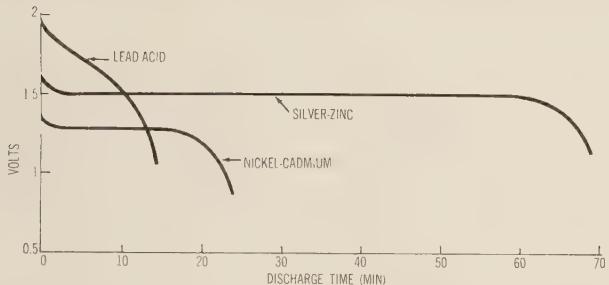
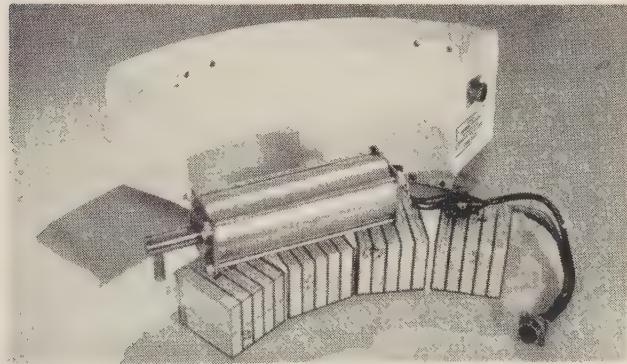


FIGURE 2: Output capabilities of three major battery types now used in commercial and defense applications.



IRBM BATTERY UNIT was contoured to an 88-deg, 11x5-in. arc. Putting out 28 V, it is rated at 14 amp and 20 minutes.

quired by the average hot-gas turbine system on a larger missile. In some cases, separate depot and logistics arrangements have become necessary.

As a result, reliability has suffered. Hot-gas turbine systems statistically should have a reliability factor of about 95 per cent. In practice, the average is about 85 per cent. On the other hand, automatically activated batteries have a calculated reliability of almost 100 per cent. In practice, recent batteries have proved to be over 95 per cent reliable. Because of its simplicity and basic electric nature, battery power requires little special training among maintenance personnel. The average electronic technician needs only a familiarization course.

It's been estimated that, if an ICBM's ethylene-

oxide hot-gas system were replaced by batteries, no performance would have to be sacrificed, but half the weight could be saved, reliability would increase by 1000 per cent, direct cost would drop 75 per cent, and maintenance and logistic costs 98 per cent or more. Because it combines long duration with little output variation, the silver-zinc battery (Fig. 2) was selected for the system on which these estimates are based. The basic battery consists of silver peroxide positive and zinc negative plates and has absorbent separators that space the plates and retain the electrolyte. The automatically activated primary battery consists of the basic battery with its electrolyte stored in an integral activator tank (Fig. 3). The cells are dry charges and require no maintenance. The unit is stored in the missile in the unactivated condition.

For activation, you simply ignite a gas-generating squib that burns at a controlled rate, producing gases to drive the piston in the electrolyte tank. Pressure is produced and transmitted by piston and fluid to a rupture plate, which breaks so that the fluid can fill the cells. Back pressure increases in the cells during fill and helps to equalize the amount of electrolyte going to each cell. The piston moves until it strikes the tank end, emptying a precise amount of fluid from the tank.

The rupture plate and its holder are made so that the plate remains in one piece after it's been burst—there are no fragments that could clog the fluid path. Activation takes place no matter what position the battery is in.

The automatically activated primary battery has been increasingly used in the missile field because of its excellent storage and instant readiness properties. However, manually activated primary batteries are also available. These show up to 60 days of stored life after activation.

Remote-activation systems have been designed for some smaller missiles. The electrolyte is inserted through an umbilical cord. This method saves weight by eliminating the airborne electrolyte storage and activation system.

Present self-activating, high energy primary batteries are extremely simple, having only one moving part. They need no maintenance or lubrication. Power output-to-weight ratios are usually very high—an average unit supplies 15 hp from only 25 lb of battery (complete with activator system). Silver-zinc units weigh one-quarter to one-third as much as comparable lead-acid or nickel-cadmium units.

### Shelf life is over five years

Reliability is excellent. No components are stressed during storage. Safety margins are wide—e.g., the cells have a continuous overload capacity of at least twice the specified current and withstand repeated short-circuiting without danger. The static nature of primary batteries insures a shelf life of up to and beyond five years. All internal parts of the unit are sealed from contact with ambient atmosphere. Wet-stand time (the period after the battery is activated) depends on the battery's function. Except for units activated in a fraction of a second and designed to maximum power-density requirements, stand time is 12 hours (without significant loss of capacity).

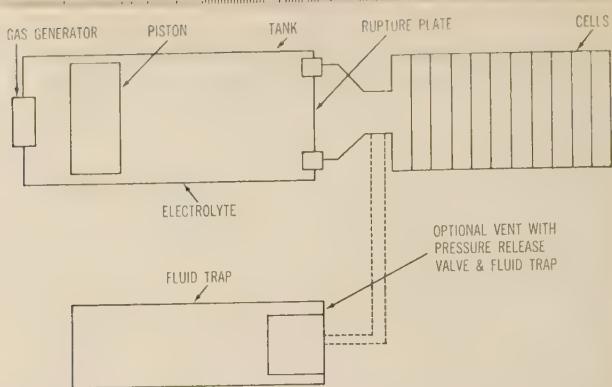
Secondary (rechargeable) batteries of sizes and  
more on next page



**SECONDARY BATTERY** is used as intermediate APU on a current ICBM.



**SEVERAL BATTERIES** can be packaged in a single container. This unit has five separate outputs but uses only one ac mechanism for simultaneous activation of the entire group.



**FIGURE 3:** Functional diagram of an automatically activated battery system (left). The only moving part is a solid-propellant-driven piston in the electrolyte tank. Near right: Battery system operating a 400-cycle alternator and a constant-displacement hydraulic pump. Far right: Silver-zinc-battery APU system with 56-V output powering a variable-volume hydraulic pump, 28-V output providing dc for instrumentation and 400-cycle current (through a static inverter), and seven-volt output supplying filament power.

weights comparable to those of primary units can be designed for test and development use. They are competitive with re-usable hot-gas systems and also provide extremely reliable electric power during critical prototype flights. Battery capacity can be readily varied as design needs change.

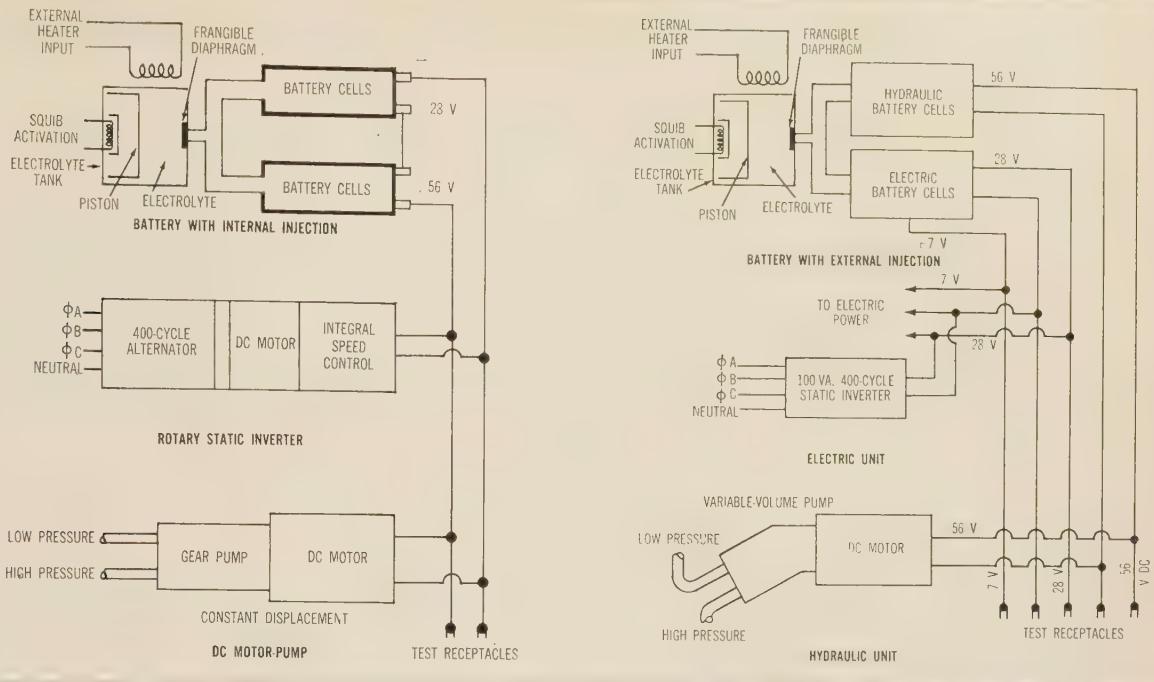
#### Cell arrangements shaped to fit

A major advantage of batteries is that cell arrangements can be shaped to specific space requirements (Fig. 4). The usual casing materials are steel, aluminum, or magnesium for lightweight applications and plastic where metals can not be used.

The operating temperature range of typical designs is -40 to +165 deg F without heaters. With heating, the cells will perform satisfactorily at ambients far below this range; insulation permits higher temperature operation. Because of inherent thermal lag, a battery that has begun operation in the normal temperature range will produce well-regulated power at temperatures far outside the usual -65 to +165 deg F range.

A primary battery, which is intended for a one-shot mission, must be used within the maximum stand time, or it will lose its charge. For a secondary battery the charge-discharge cycle capability depends on many factors, but most important are operating temperature, the care used in charging, and other maintenance steps. Shelf life is essentially infinite for the dry state and about one year after filling with electrolyte. The number of cycles may be as few as 10 under the worst circumstances and over 100 at moderate discharge rates and other optimum conditions.

Secondary or manually activated batteries should be installed so they're easily accessible. Automatically activated units may be "buried" as deeply as desired,



since no servicing is needed. Gassing of the battery during use, once a problem requiring vent hoses and the like, has been eliminated in current units. Today, even the largest automatic batteries vent no gas during a normal discharge.

The development of special-condition detection circuits has made it possible to determine accurately the readiness of an unactivated primary battery. Continuity and insulation resistance of all a battery's electric circuits may be checked in the usual ways. The squib ignitor may, in most batteries, be checked without special instruments. A new premature-activation unit detects passage of electrolyte beyond the storage tank diaphragm. In five seconds, this detector will either make or break a 10-amp circuit in response to three drops of electrolyte. Under development are additional electric indicators, including a true indicator of state of charge.

### Most APU units are 28 or 56 V

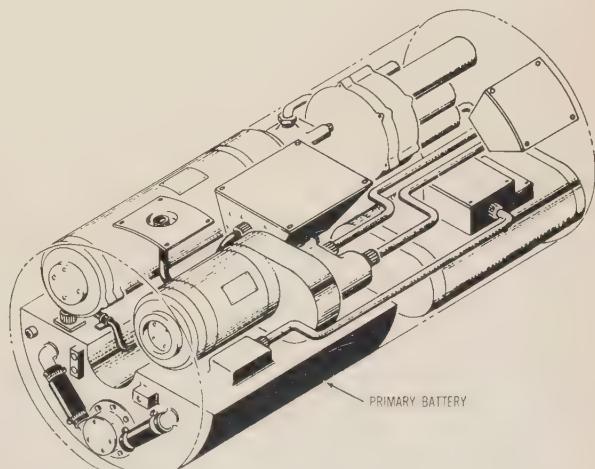
Batteries for APU use are generally supplied in either 28 or 56 V. A need for 56 V may arise because the system manufacturer has overrated electric motors and other equipment for short-duration operation. By tapping, both 28- and 56-V equipment can be operated from a 56-V battery.

In terms of weight, the battery APU generally works out best in the ranges of 1-10 minutes and 1-10 kw. However, because of their many advantages, batteries are often used outside these ranges.

In the simplest system, the elements are a battery, a dc motor for a hydraulic pump, and a static inverter for ac. The development of an efficient static inverter has eliminated the need for a dc motor with integral speed control and for an alternator or a hydraulic motor and alternator arrangement, for ac.

There appear to be at least three major trends in system and component design that favor the wider use of battery APUs:

- increased use of transistorized and other low power consumption circuits;
- progress in flyable static inverters, including three-phase, multi-kva units;
- continuing improvements in the energy and weight efficiency of hydraulic accessories. Write in No. 79 on Reader Service Card for more information.—End



**FIGURE 4:** Specially shaped primary battery for a typical missile guidance-control unit.

# Deflected slipstream gives good VTOL characteristics

A number of new VTOL designs have made their appearance as a result of current Army-ONR programs. One of the most interesting is Ryan's Vertiplane, built to test the deflected-slipstream method.

by Irwin Stambler, Associate Editor

**T**HIS VERTIPLANE, designed by Ryan Aeronautical Co., 2701 Harbor Drive, San Diego 12, Calif., represents one of several new concepts under evaluation in a current Army Office of Naval Research VTOL program. Ryan is among several firms chosen to build and test various VTOL configurations, including the Doak 16, a ducted-fan design, and the Vertol 76, a tilt-wing craft. Ryan's Vertiplane was developed to study the deflected-slipstream principle.

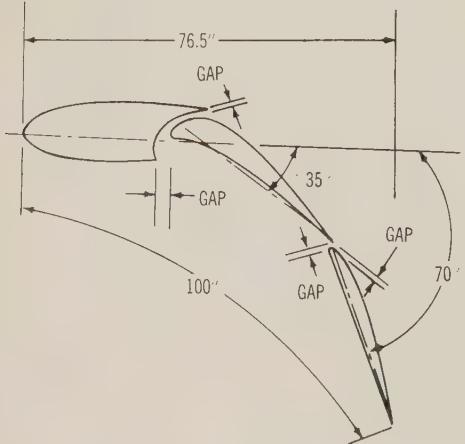
As Ryan engineers told SPACE/AERONAUTICS, their basic problem was to find an efficient way of turning

the slip-stream so that they would be able to raise a reasonable payload. Of all VTOL craft, they note, the helicopter possesses the greatest vertical lifting ability for its power, but it's limited in speed and altitude, because it's essentially a hovering device converted to flight. Jet VTOLs, on the other hand, have virtually unlimited high speed and altitude potential—with low lifting capacity, because the high speed jet stream is relatively inefficient when it comes to lift at low speeds. Approaches like the deflected-slipstream and tilt-wing methods suggest a possible middle ground.

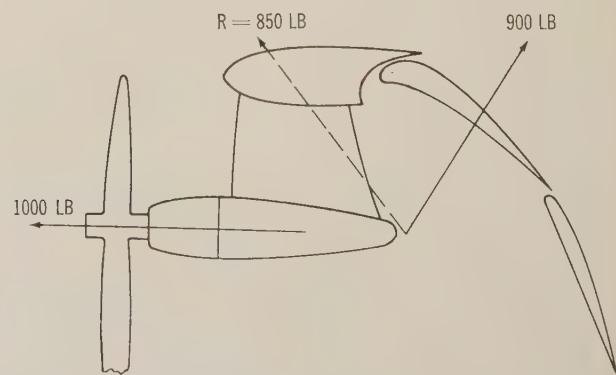
To find the best wing-flap arrangement for its design, Ryan built a full-scale wing and flap system. This was tested for various flap positions in a rig in which air flow was provided by a 260-hp propeller system. Different types of flaps were tried out with a wide range of gap settings before the configuration of *Figure 1* was chosen.

The tests showed it was best to use a flap system that extends the wing area as much as possible. A stubby wing with a relatively large chord would have given poor stability. On the other hand, the larger chord was better for VTOL performance.

**FIGURE 1:** Vertiplane wing with flaps fully extended shows compromise between large and small chord.



**FIGURE 2:** Rough sketch shows how about 15 per cent of assumed 1000-lb forward thrust are lost in VTOL.





**RYAN VERTIPLANE** in flight test. High horizontal tail surface reduces tail lift in hovering, which tends to force the nose down. Full hovering tests have not yet started.

### Ryan Vertiplane

#### Areas

Wing (Incl. Endplate Planform)	125 sq ft
Horizontal Tail	52 sq ft
Stabilizer	33.3 sq ft
Elevator	18.7 sq ft
Vertical Tail	18.8 sq ft
Fin	13.8 sq ft
Rudder	5 sq ft

#### Weights

Empty	2293 lb
Useful Load	425 lb
Gross	2718 lb

#### Military Power Rating (Lycoming XT53)

825 shp

#### Aspect Ratios:

Wing	4.4
Horizontal Tail	3.13

#### Loadings

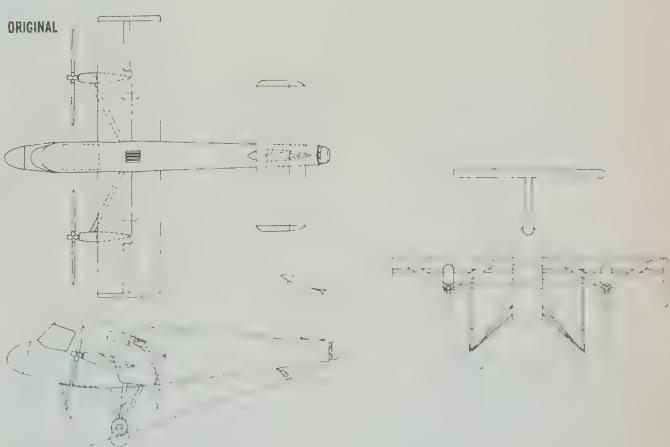
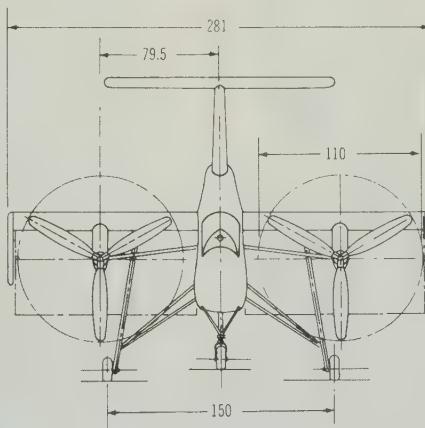
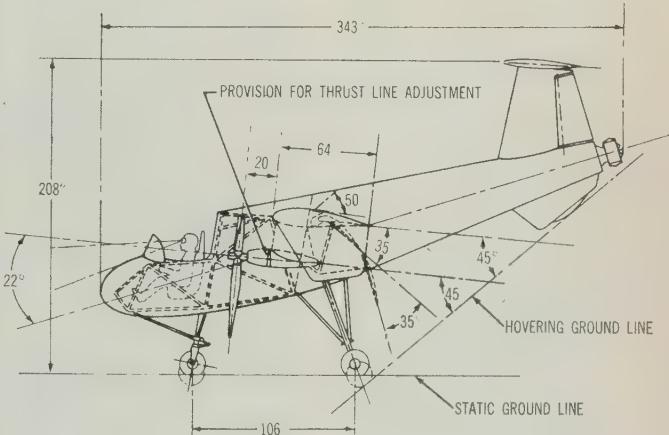
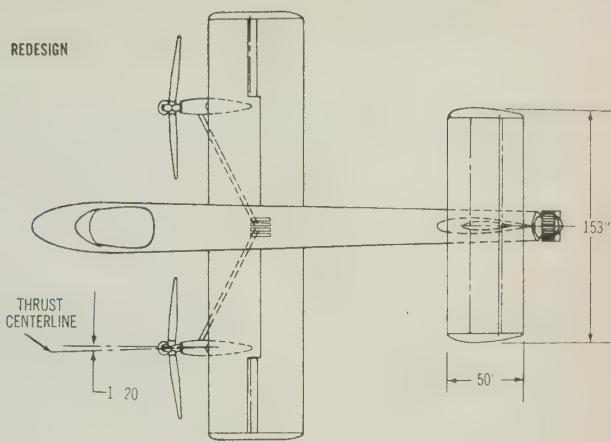
Wing	21.7 lb/sq ft
Power	3.3 lb/shp

A thick (18 per cent) wing was selected for structural reasons. Its section is NACA 45-18. As Figure 1 shows, the flap arrangement provides a good compromise between a short chord (for stability) and a large one (for VTOL). The basic wing chord is 64 in., but with the flaps fully extended the chord is 100 in.

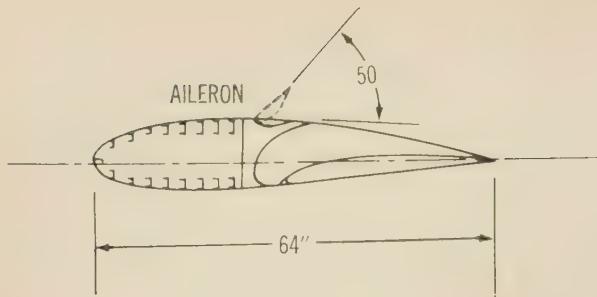
The gap dimensions were set during stationary tests. First, the critical setting for the top gap was found. This gap was then fixed, and the other gaps were varied. The process was repeated for the other gaps until the best configuration was established.

Next, different angles of travel were tried out. Ryan decided the best approach was to have the lower flap

**more on next page**



**THREE VIEWS** of original and redesigned Vertiplane configurations show drastic changes in cockpit design.



**FIGURE 3:** Vertiplane wing with retracted flaps. The ailerons are located between wing box and flaps. All wing torsion and bending loads are carried in the box.

move down twice as quickly as the upper to a maximum angle of 70 deg.

The static tests also showed the need for end plates. Without these, performance was little affected at small flap settings, but at higher settings their lack markedly reduced the efficiency.

As *Figure 2* shows, for a forward thrust of 1000 lb the wing reaction would be about 900 lb and the resultant force about 850 lb. With four propellers instead of two, these values would have been improved somewhat, but Ryan decided that the 10-15 per cent loss in turning the slip-stream was acceptable for test needs.

Of course, the setup of *Figure 2* wouldn't permit vertical take offs. For those, the landing gear had to be designed so that the plane sits on the ground in a nose-high attitude. This problem is typical of 'copters, project engineer Fred Landgraf points out, which must be positioned nose-up for hover, and nose-down for cruise.

The propellers are 110 in. in diameter and have very wide blades. Because of their great width, they are made of wood. Both are driven by shafts that are connected to the main gear box bolted onto the single Lycoming T53 engine, which is mounted in the fuselage. The prop centerlines are 20 in. forward of the wing leading edge and 79.5 in. from the plane's centerline.

### Commercial prop hubs are used

The props were specially built. However, to save on a high-cost item, hubs from commercial props are used. The hubs were selected first, and the prop manufacturer was then asked to design special, matching blades that would produce maximum static thrust. Blade weight came out the same as for standard metal types, so that the stresses weren't above those for which the hubs were designed.

The high horizontal-tail position resulted from NASA wind tunnel tests that showed that, with lower positions, tail lift in the hovering attitude tended to force the nose down. A large tail area resulted because the CG is 55 per cent aft of the wing leading edge (as against only about 35 per cent in conventional designs).

As *Figure 3* shows, the aileron operates in the gap between the wing and the first flap and has a maximum travel of 50 deg. This is enough for speeds down to 30 knots. Prop differential pitch takes care of roll control at lower speeds. This system is automatically engaged or disengaged by the flap actuation system.

At speeds under 30 knots, the normal tail surfaces are ineffective for pitch and yaw control. This control then is provided by deflection of exhaust gas from the engine through a tailpipe nozzle. At present, this system

is connected at all times. At high speeds, Ryan engineers point out, the plane doesn't use as much power as at low speeds, so the nozzle effect diminishes as flaps are retracted.

In tests to date, this system has worked well. The 12-ft-long tailpipe installation follows the Ryan-developed Miniwate construction and is made of 321 stainless. It only weighs 16 lb.

Flight tests so far have included only normal take-offs and landings—Ryan wants to run the first hovering tests at safe altitudes. In late summer, the test series had reached the point of flap extension to 40 deg (out of 70) and of flight speeds as low as 26 knots.

A few ground tests were run in which the plane was brought almost to the point of hovering just to test control response. These tests showed the plane has adequate control for its hovering range.

For the moment, tests have been interrupted by a mishap due to problems in getting the props rigged for differential control. This control system wasn't engaged for the earlier, non-hovering tests. In connecting the system, changes had to be made in the prop counterweights. The changes worked well on the ground and in other tests. However, the control system didn't respond correctly in the air, and the craft was damaged in landing. Flight tests are to be resumed shortly.

### Nose wheel is used for STOL

When taxi tests of the Vertiplane began, normal take-offs proved difficult—with the nose high, the wing became airborne before the tail, because of the slipstream. A nose wheel solved the problem, the pilot then found it is very easy to take off in the normal way. However, it's expected that, when more is known about the plane's handling characteristics, it will be possible, if desired, to eliminate the nose wheel.

A major advantage of this Vertiplane design, Landgraf told SPACE/AERONAUTICS, is that the wing doesn't stall in the usual sense of the word—not even without full power. Any horsepower from 20 on up prevents stall, and so you get an excellent STOL craft. In this respect, Landgraf states, deflected slip-stream is better than a tilted wing (unless the latter has flaps).

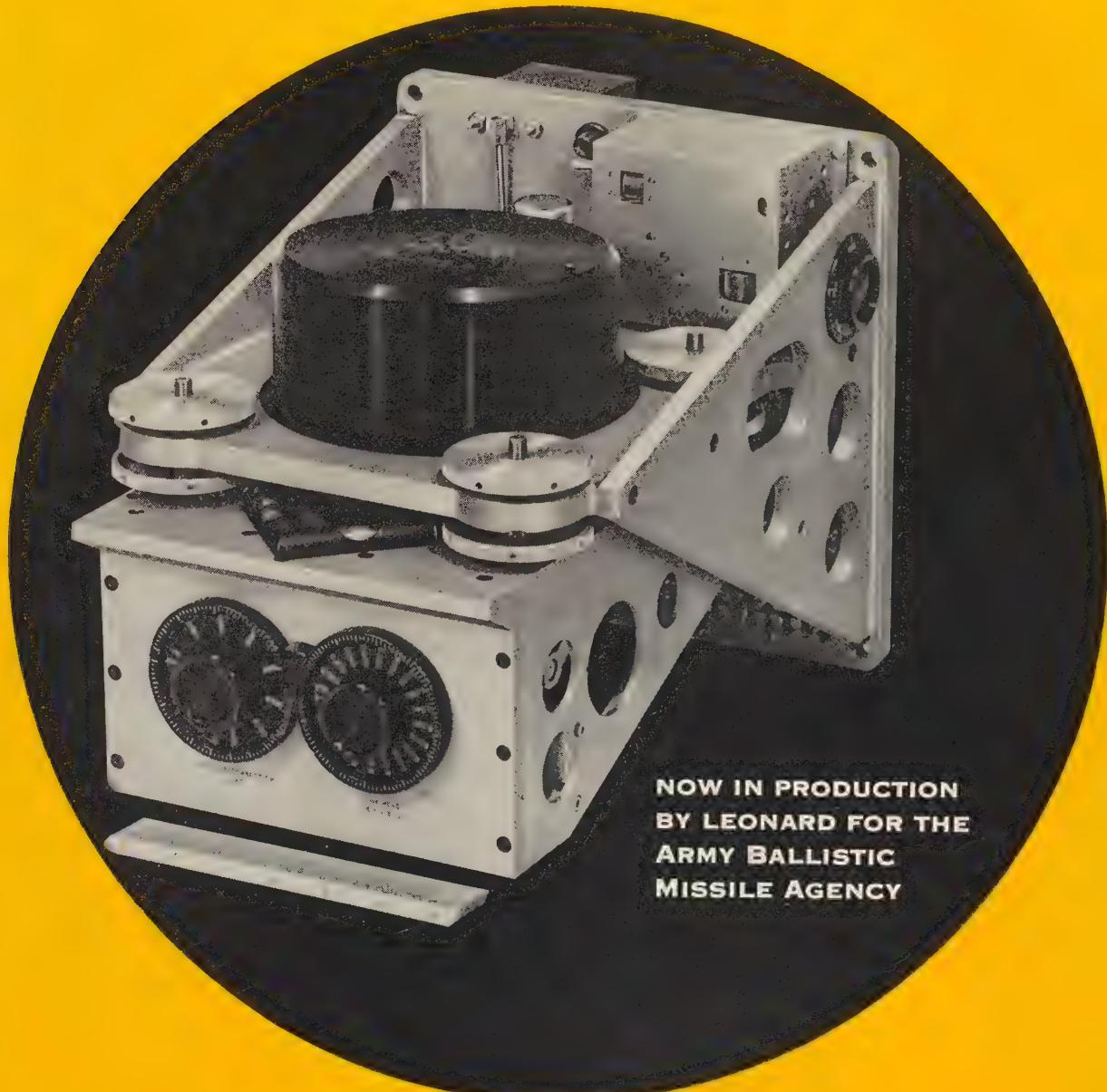
Landgraf also points out the Vertiplane is a straightforward aircraft, completely under the pilot's control and simple and rugged in construction. One of the problems with 'copters, from the Army's point of view, is complex machinery. It's difficult, Ryan engineers note, to keep some types of 'copters in operation under adverse conditions. One of the goals of current VTOL programs is to develop simple designs that will be easy to maintain in the field.

The Vertiplane structure is mainly 24ST aluminum. Spot welding is used widely to get lightweight structure made of very thin skins with closely spaced stringers. On the horizontal tail, the rudder, and parts of the fuselage, 0.012-in. thick skins are used. The rest of the fuselage has 0.016- or 0.62-in. skins. The wing and the wing flaps have 0.016-in. skins with local reinforcements in places of high stress. The design was made structurally strong enough for a forward top speed of 180 knots. The front end of the plane has been redesigned with an internal tubular steel structure.

With all instrumentation, the craft has a gross weight of 2718 lb. Instrumentation weight is 150 lb. Length is 28 ft, 7 in.; height over tail, 17 ft, 4 in.; wing span, 23 ft, 5 in.; and distance between nose and main landing gear, 106 in.—End

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Bomarc missile,  
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pad at Cape  
Canaveral.

*Photo: Courtesy Boeing Airplane Company*

## Fafnir Ball Bearings help keep Bomarc missiles "on tap"... and on target!

Used in the outboard rudder control gear box of the Boeing Bomarc, Fafnir ball bearings meet several important design requirements for Indiana Gear Works, designers of this vital missile component.

Fafnir prelubricated and shielded ball bearings and bearings with Plya-Seals, for example, provide positive, built-in protection against contaminants. These bearings remain trouble-free, require no servicing, help keep the Bomarc ready to go at moment's notice.

Uniform high quality is another must. Fafnir quality control insures bearings that consistently meet exacting tolerance and dimensional requirements, installation after installation.

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Rudder control gear box, developed by Indiana Gear Works of Indianapolis, incorporates both Fafnir contact-type Plya-Seal ball bearing, extra-light series (left) and Fafnir double shielded type.

**FAFNIR**  
**BALL BEARINGS**



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SPACE/AERONAUTICS



**FIGURE 1:** Flow of the brazing alloy over the concave ring in the diffuser's rear flange plate, which must not be brazed, is prevented by Green Stop-Off (left). The



paint-like material is applied by brush. Right: The powdered brazing alloy is applied by brush to the shoulder on the rear flange plate by Wall Colmonoy workman.

## Brazing high temperature assemblies

Among the production methods that have suddenly come into favor again because of the heightened requirements of advanced aerospace vehicles, brazing is one of the most important. Here is a detailed report on how it is applied in the case of a diffuser for a current jet engine.

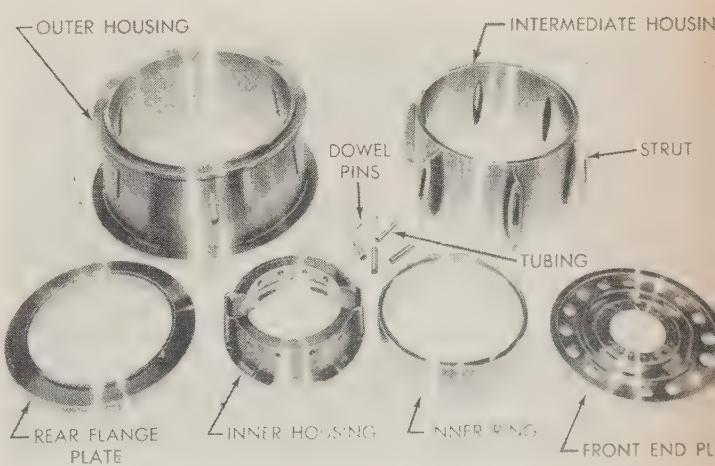
**TOLERANCES** of  $\pm 0.002$  in. are being held consistently in controlled-atmosphere furnace brazing of jet engine diffusers at Wall Colmonoy's Stainless Processing Div. Figure 2 shows the parts making up the diffuser assembly. They are made from AISI 321 stainless. The struts are welded to the intermediate housing and machined to finished dimensions prior to handling. The inner housing is also made up as a weldment.

In preparing the diffuser parts for brazing, Wall Colmonoy uses a barrier against brazing alloy flow on surfaces that must not be brazed. "Green Stop-Off", a paint-like substance, is applied as shown in Figure 1.

Another unusual step in the processing of the diffuser is the spraying on of the brazing alloy to mating surfaces that form a butt joint and on which alloy cannot

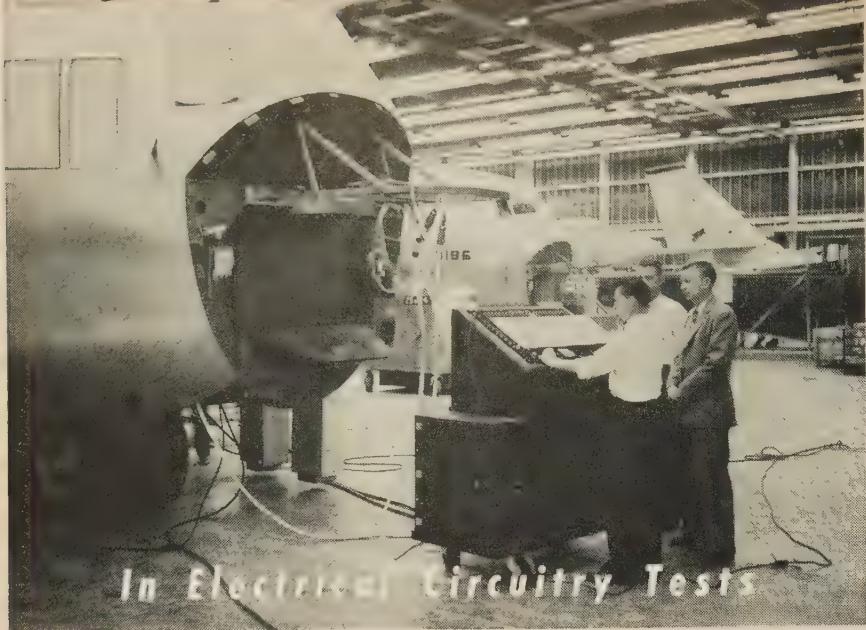
**by R. L. Peaslee**, Vice President, Stainless Processing Div., Wall Colmonoy Corp.<sup>1</sup>

**FIGURE 2:** Parts of stainless steel jet engine diffuser that is furnace-brazed in one piece at Wall Colmonoy.



<sup>1</sup>(1) Stainless Processing Div., Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mich.

more on next page



## DIT-MCO Is Faster and More Reliable Than Other Methods

Take tape read-out tests, for example. This method requires extra machines to translate test information or a genius to remember the code used on the tape. Either way, it's a costly process. Compare this to the DIT-MCO Automatic Circuit Analyzer and its exclusive Matrix Chart.

The DIT-MCO Circuit Analyzer performs the entire test itself. There's no need for complex machines to translate test information. All data concerning errors, circuit numbers, type of flaws, etc., appears on the Matrix Chart, so there's no need for complicated wiring diagrams or charts! And, the DIT-MCO Circuit Analyzer checks one circuit against all others... over 2,000 in about three minutes... with accuracy never before possible in any test system.

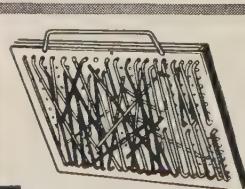
Some testers are a maze of colored, flashing lights. Operators of such test machines must refer to 100, 500 or even 1,000 miniature lights to try and locate errors. Charts and diagrams must also be used... with a resultant high number of human errors.

The DIT-MCO Circuit Analyzer injects human decision into every test but in such a way that chances of human errors are nil. The easy-to-read Matrix Chart employs only two lights to quickly pinpoint every circuitry flaw. Yet, anyone, with less than one hour's instruction, can operate the DIT-MCO Automatic Circuit Analyzer and perform test functions once thought impossible!

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**FIGURE 3:** Brazing alloy is sprayed into the inner housing to afford unusually close control of alloy thickness. After brazing, the housing is totally enclosed and cannot be machined.

be placed by any other method.

Powdered brazing alloy is generally used for high temperature assemblies of this kind. The L. C. Nicrobraz<sup>2</sup> alloy used at Wall Colmonoy is mixed with Nicrobraz cement, and the mixture usually is applied by glass dropper or brush (*Fig. 1*).

### Nicrobraz is designed for high temperatures

L. C. Nicrobraz is a nickel-base chromium-boron-silicon brazing alloy specially designed for high temperature service. Conventional application by glass dropper or brush is generally satisfactory; only rarely do parts have to be machined after brazing.

On an expensive assembly like a diffuser, it's normally preferable to allow excess material (stock) on critical dimensions to make very close final tolerances possible. However, in the case of the assembly shown in *Figure 2*, the inner housing is completely enclosed once the brazing operation is finished, so all supplementary machining is ruled out.

### Dimensional control by paint spray

The problem of critical dimensional control in this case was solved by Wall Colmonoy through spray application. After proper masking of the part, L. M. Nicrobraz alloy is applied with an air-

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more on page 160

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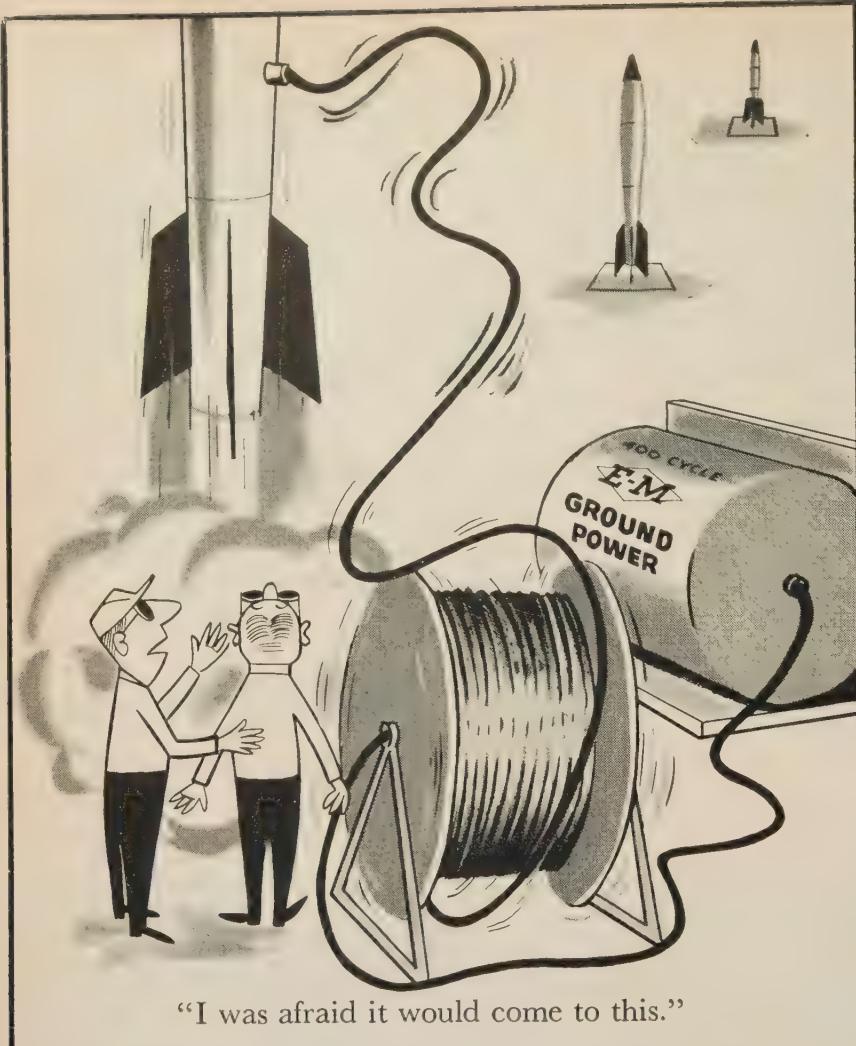
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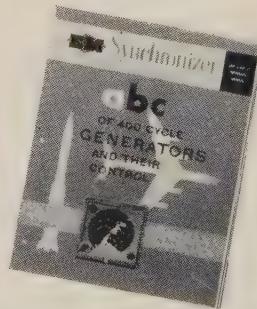
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**FIGURE 4:** Retort bell is lowered over a diffuser assembly ready for brazing (in one of the furnaces in the background). Thermocouple wires can be seen leading to the retort base and the inside and outside of the diffuser. The thermocouples are used for close temperature control throughout the brazing cycle.

type paint spray gun (Fig. 3). An experienced brazing technician can closely control the overlay thickness obtained with each pass of the spray. After each pass, the overlay thickness is checked with a micrometer. In this way, thickness is held to  $\pm 0.001$  in.

### Brazing temperature is weld to $\pm 10$ deg F

After application of the brazing alloy, the diffuser is fully assembled and inspected. Then it is ready for brazing, which is done in special furnaces using a pure, dry hydrogen atmosphere. During the entire brazing cycle, temperature is controlled to  $\pm 10$  deg F. Whenever an assembly with critical dimensional tolerances is brazed, a multi-thermocoupled circuit is used to provide the necessary close control of the furnace temperature (Fig. 4).

The assembly is placed in a retort, which in turn is placed in the furnace. The diffuser is raised and centered within the retort to get better hydrogen circulation. Because of the critical dimensional tolerances, the diffusers are brazed one at a time. After brazing, neither pickling, brushing, nor cleaning is needed. Write in No. 77 on Reader Service Card for more information.—End

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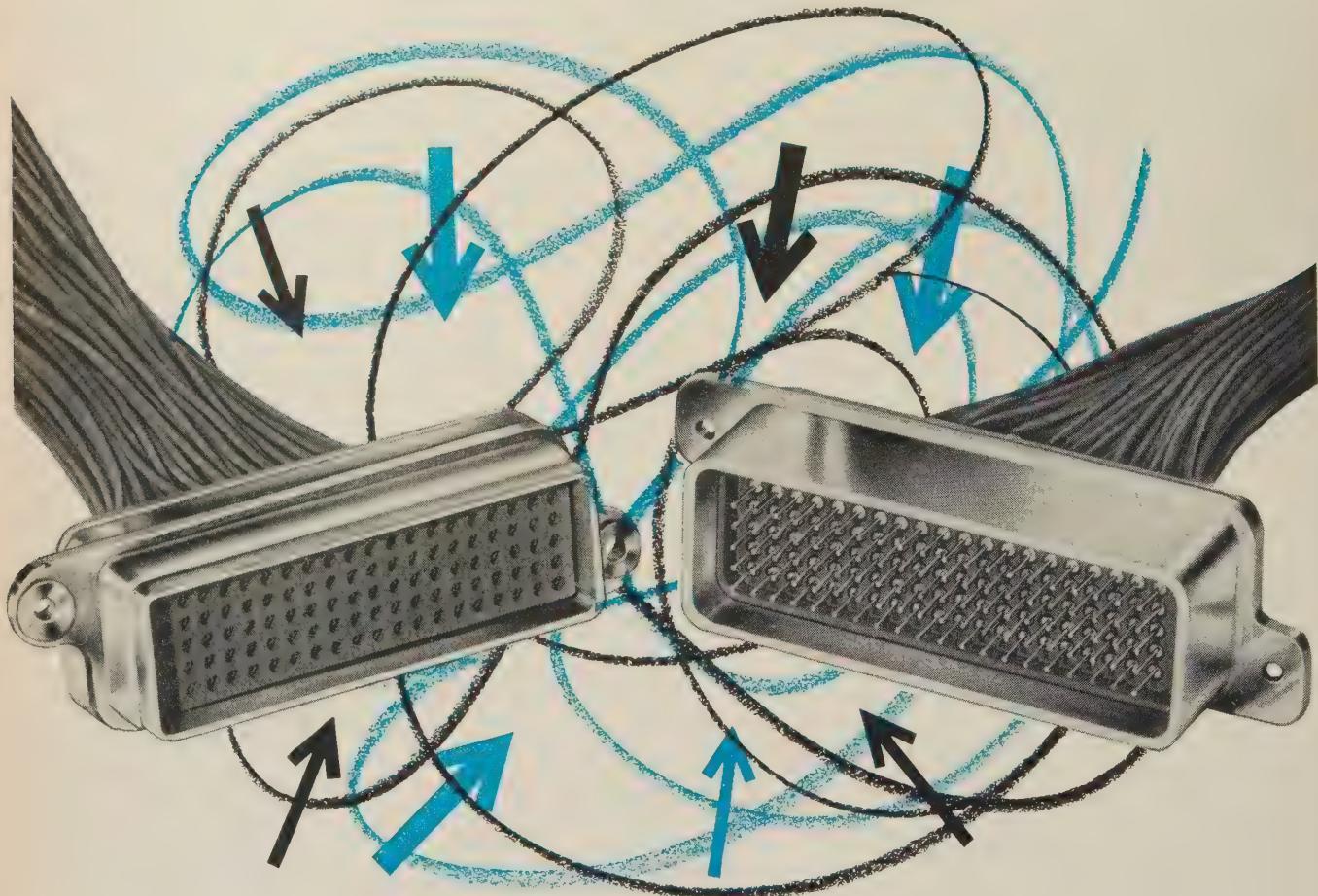
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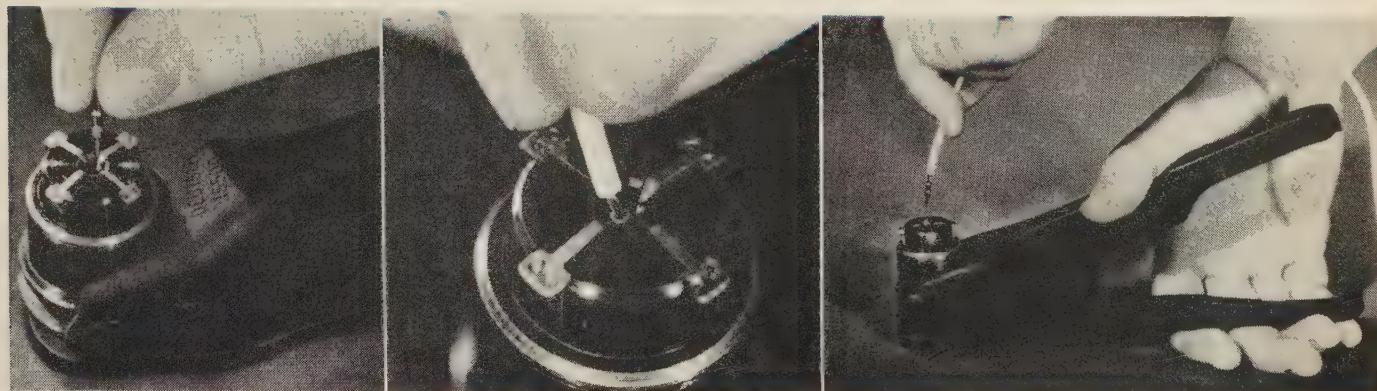
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DROP contact head down  
into the crimping tool . . .

. . . insert stripped wire in open  
contact end and depress lever . . .

. . . remove contact once positive  
crimp is insured . . .

## New inserts, terminations, contacts for high performance connectors

In years past, the electric connector was rarely more than an afterthought in aerospace system design. Today, it has to be engineered from the beginning to the severe environmental requirements of advanced missions.

**by Sid Marshack**, Chief Field Engineer, Electronic Components Div., The Deutsch Co.\*

**T**HE electric miniature connector as such has been with us for a long time. However, miniaturization alone does not meet the increasingly stringent requirements of the electric systems in our advanced aerospace vehicles. What is really needed is a miniature connector that is easy to install and will prove completely reliable in the most extreme environments.

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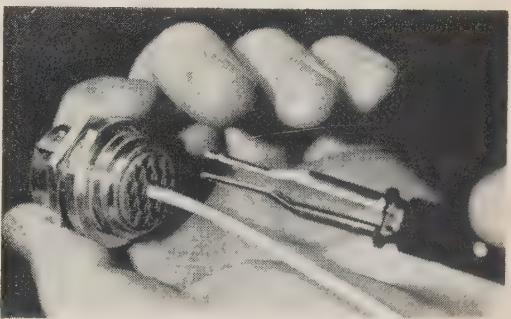
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. . . place contact and wire assembly  
in jaw of insertion tool . . .



. . . push contact into back end of  
connector . . .



. . . slip insertion tool out as soon as  
contact is seated . . .

\* Electronic Components Div., The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.

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A silicon-based insert material has been developed for these connectors that can take higher temperatures than any resilient dielectric now used for the same purpose. In tests, it has shown no reversion or degradation in 120 hours at 400-450 deg F and no appreciable change in physical or electric characteristics in two hours at 600 deg F. In contrast, Mil-C-5015 and -C-2648 specifies highs of only 187 and 257 deg F, respectively for insert materials for electric connectors.

The destructive action of the silicon polymers freed by high temperatures is controlled by a chemical additive as well as by the molding process. As a result, the material is reliable enough for 200 hours' continuous operation at 400-600 deg F.

The hardness of the silastic has been reduced from 75-80 to 35-40 shore, which makes for better pressure sealing of the mated plug and receptacle. In this way, the insert, whose elastic characteristics also keep it from taking a permanent set, guarantees reliable operation at altitudes of over 100,000 ft.

Tear resistivity, long a headache with silastics, also has been greatly improved. In standard Mil spec tests, the new silicone has been stretched 250 per cent before tearing.

It's generally admitted that poor quality control during assembly is

*more on page 168*

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Originators of high temperature fluorocarbon hose assemblies

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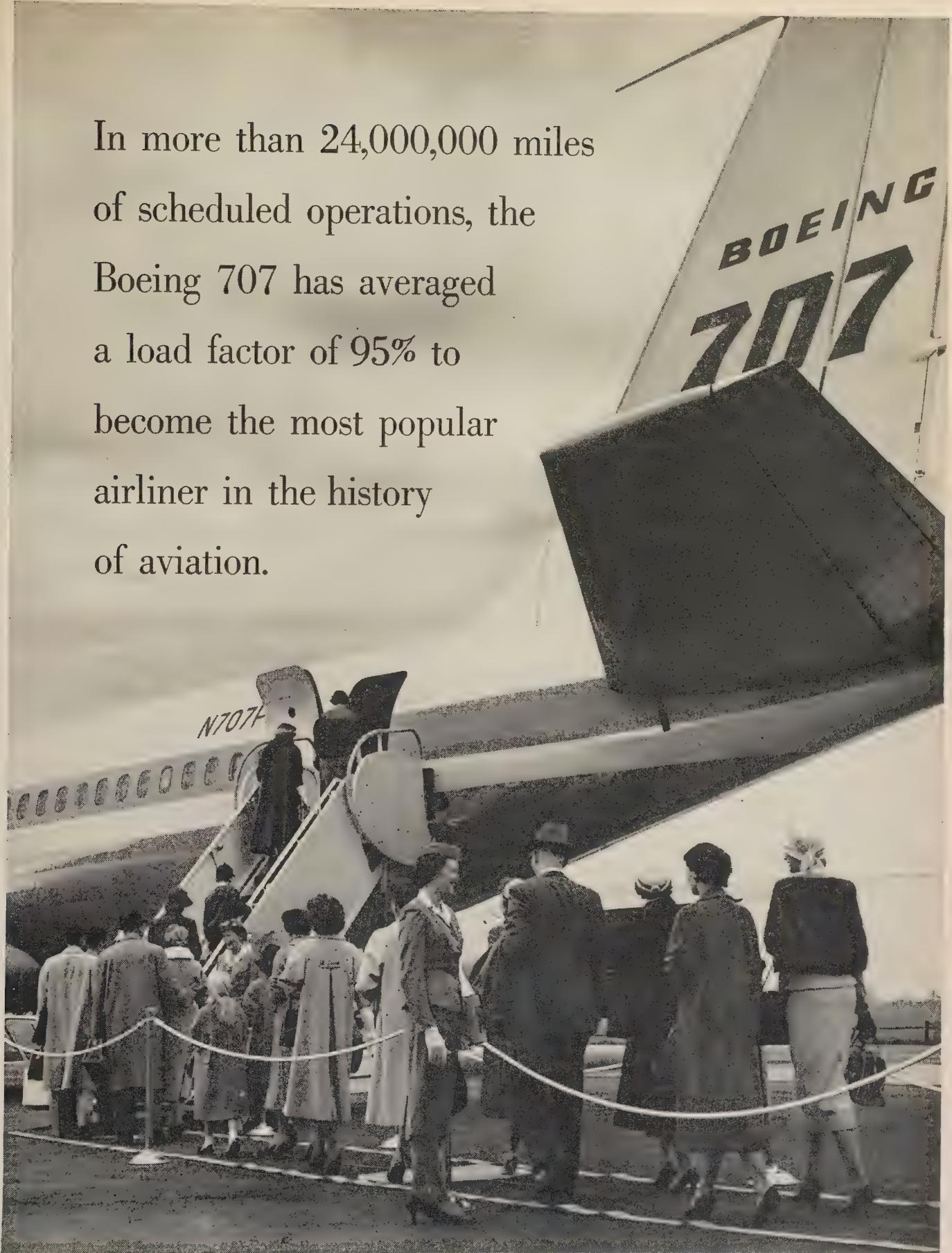
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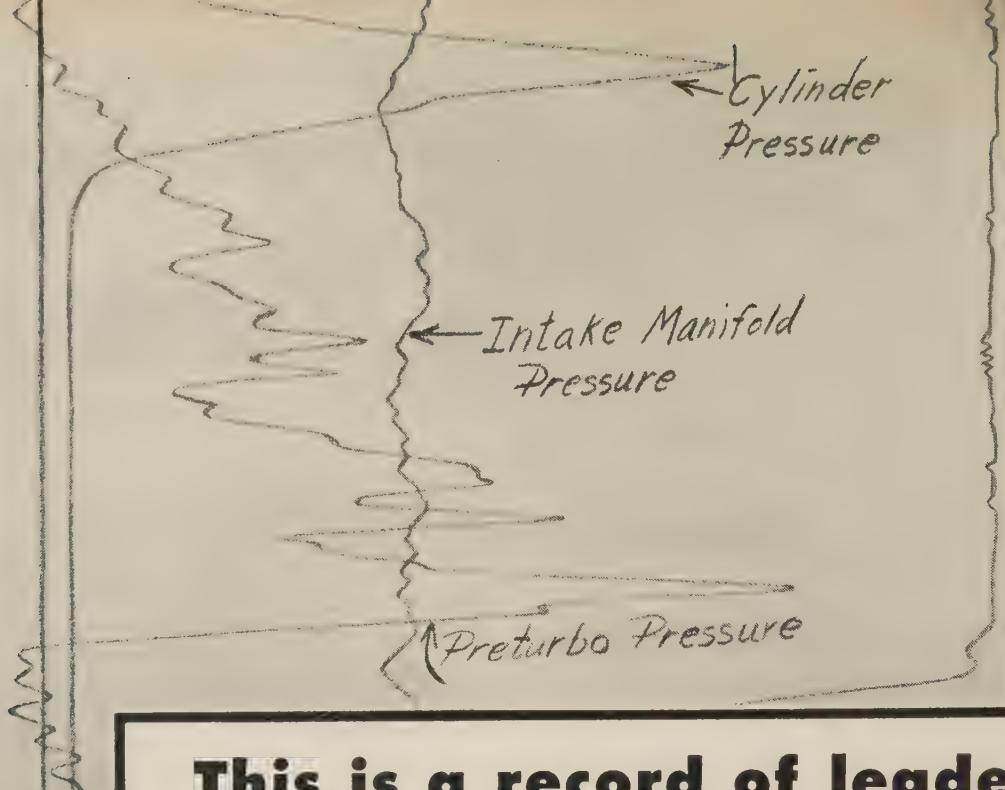
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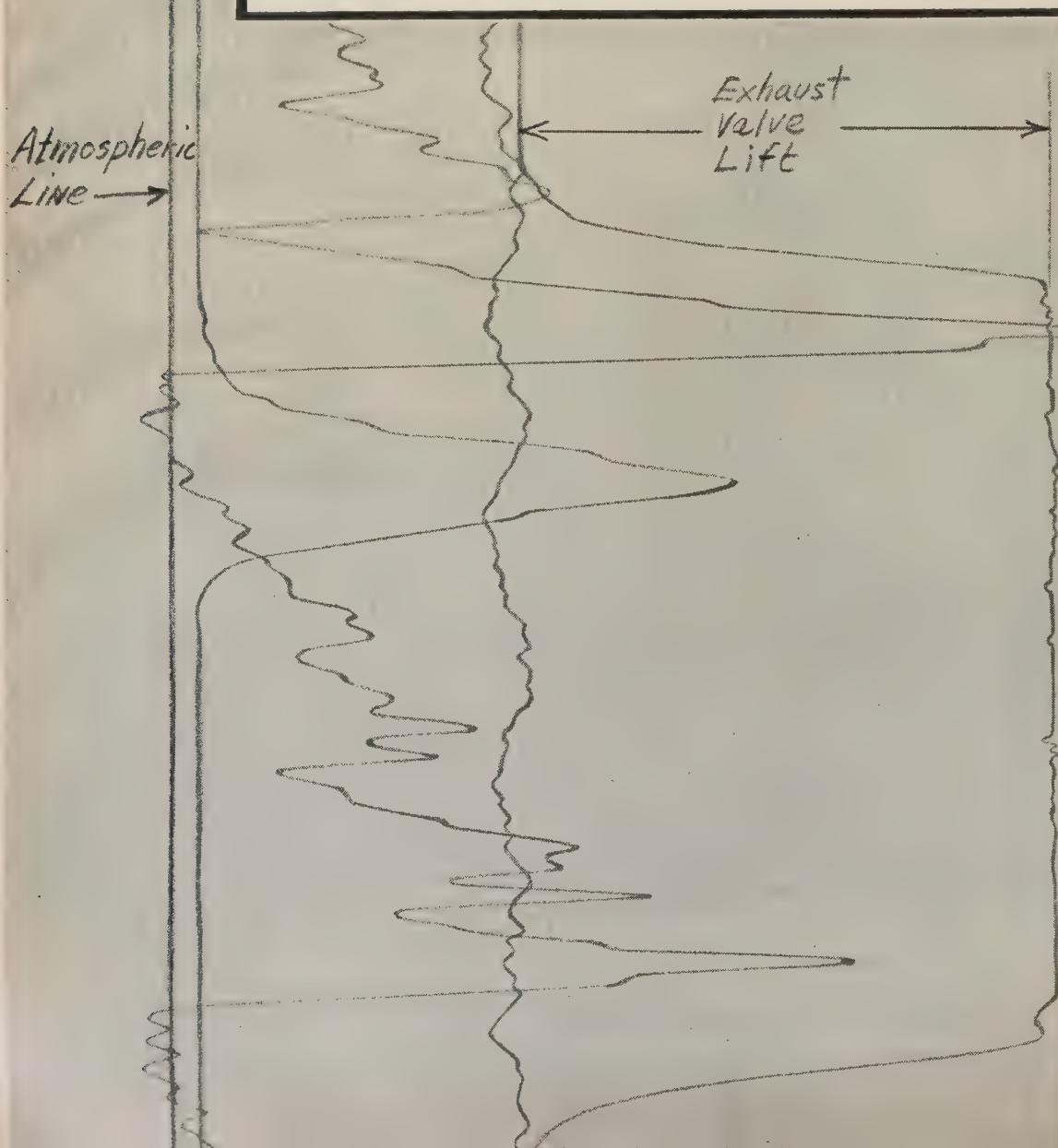


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The Worthington Corporation used a Honeywell 906 Visicorder to chart the heartbeat of a Worthington Tripower diesel engine. These Tripower (oil fuel, dual fuel, or spark ignition gas) engines have a fourteen inch bore; an eighteen inch stroke, and develop more than 265 h.p. per cylinder at 450 RPM.

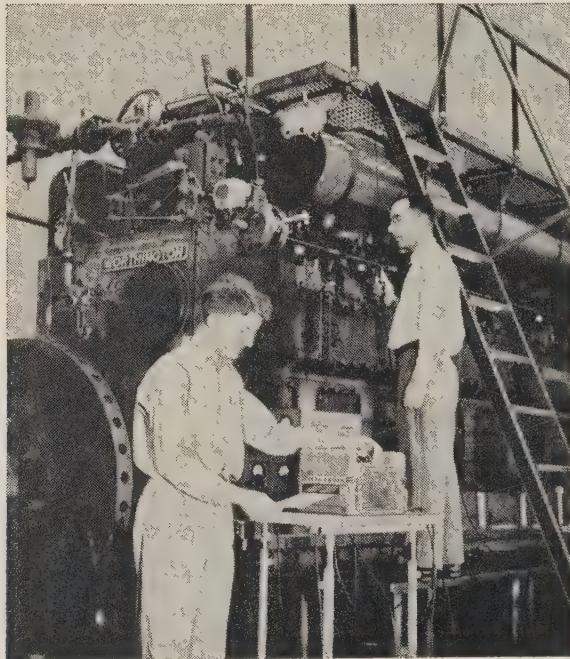
The Visicorder used in these tests makes a direct, instantly-readable record of the pressure variations in the exhaust manifold, cylinder, and intake manifold to determine optimum valve

timing and engine configuration. The Visicorder also produces a permanent record of strain gauge measurements taken on the frame and other critical engine parts.

For the manifold and cylinder pressures, strain gauge pressure transducers and a strain gauge amplifier were used. For the valve lift patterns, a linear potentiometer powered with a small battery was connected directly to the Visicorder.

Analysis of these data has led to changes in the Tripower engine for best performance.

## in diesel engine research



Ted Dupler (left) and John McAllister, Worthington Engine Research Engineers, measure intake manifold, cylinder, and exhaust manifold pressures and valve stroke on a Tripower with a Honeywell 906 Visicorder.

The Honeywell Visicorder is the pioneer and unquestioned leader in the field of high-frequency, high-sensitivity direct recording oscillography. In research, development and product testing everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

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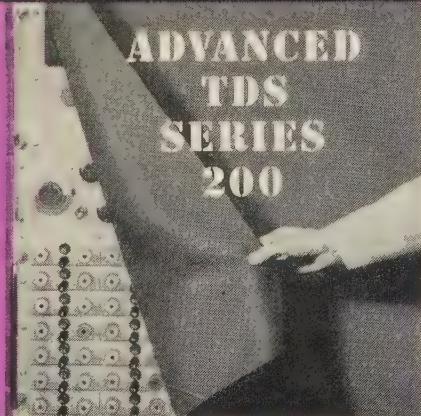
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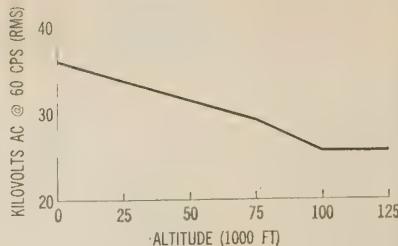
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**CONNECTORS . . .**



**AVERAGE** test voltages of high potential flash-over for DS connector.

the most frequent cause of connector failure, and that poor workmanship in turn shows up most often in the soldering operation. Getting rid of the solder joint therefore represents a major breakthrough in connector design.

Instead of the solder joint, a contact design with a crimp-type termination is used. In tests, this design showed less electric resistance than a similar solder contact. A #20 contact (with a 0.04-in.-diameter pin) showed a drop of less than six millivolts—which is quite a bit better than the 20 mv allowed in Mil-C-8384. Used together with a high temperature silastic insert material, this low-resistance contact has raised the current rating of the #20 unit from 7.5 amp to a full 10 amp.

Naturally, for a crimp-type contact you need a proper crimping tool. Such a tool is now being offered and will give:

- positive location of the contact in the tool before crimping die closure;

- circumferential eight-indent, symmetrical crimping of the contact without distortion or harmful stresses;

- completely and uniformly reproducible crimping cycles.

The crimped connection has shown less resistance in tests than an equally long wire and a retention equal to that of #20 gage wire itself. The crimping tool is readily adaptable to both hand and bench operations.

Continuing miniaturization has made connectors increasingly difficult to assemble. This fact has led to the development of a contact that "snaps" into the connector insert and is easily removed again without any damage to either wire, contact, or connector. The Table shows how much simpler this

**more on page 170**

SPACE/AERONAUTICS

A new division of  
The Dow Chemical Company—

# THE DOW METAL PRODUCTS COMPANY

Here's significant news for everyone who has an interest in metals and metal fabrication. The Dow Chemical Company, pioneer developers of Magnesium and Magnesium products, is now broadening its activities in metal working. A new division, THE DOW METAL PRODUCTS COMPANY, has been formed to specialize in the semi-fabrication and fabrication of not only

Magnesium, but aluminum and other metals. This new division has excellent production facilities, plus knowledge gained through Dow's many years' experience in the metal working field. Facilities include plants for the manufacture of rolled and extruded products, sand and permanent mold castings, die castings, and fabricated assemblies.

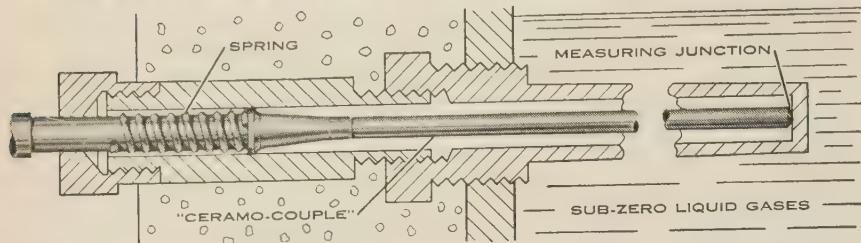


**THE DOW METAL PRODUCTS COMPANY**

DIVISION OF THE DOW CHEMICAL COMPANY  
MIDLAND, MICHIGAN

Write in No. 125 on Reader Service Card at start of Product Preview Section

# Sub-Zero Ceramo-COUPLE Solves Condensation Problems



"Ceramo" versatility has also solved a key problem of *sub-zero temperature measurement*—condensation. Caused by wide temperature differences between ambient temperatures and the thermocouple measuring point, condensation can penetrate thermocouple insulation and short out conductors.

**Overall Metal Sheathing** of "Ceramo" thermocouple wire completely encloses conductors and ceramic insulation—shutting out moisture effectively. Sheathing

itself is stainless steel or other corrosion-resistant material.

**Spring-Loaded Construction** of T-E's sub-zero probe holds contact point firmly against thermowell end—counteracting effects of expansion and contraction from temperature changes.

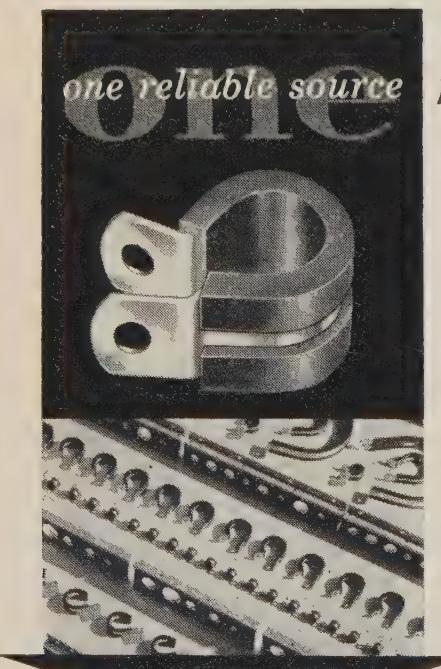
**Applications**—Liquid oxygen, nitrogen, ammonia and similar applications. Conductors are either Copper-Constantan or Chromel-Constantan for measuring temperatures as low as  $-320^{\circ}\text{F}$ .

**Write For Bulletin 52-A**

**Thermo Electric CO., INC.**  
SADDLE BROOK, NEW JERSEY

In Canada:  
THERMO ELECTRIC (Canada) LTD.,  
Brampton, Ont.

Write in No. 126 on Reader Service Card at start of Product Preview Section



for all your  
**CLIP, BLOCK and**  
**HARNESS STRAP**  
**needs!**

ADEL offers the widest variety of LINE SUPPORTS in the World... 19,000 different types and sizes for safe, vibration-free, positive support in all types of aircraft, missiles, rockets, ordnance, automotive and original equipment of all kinds.

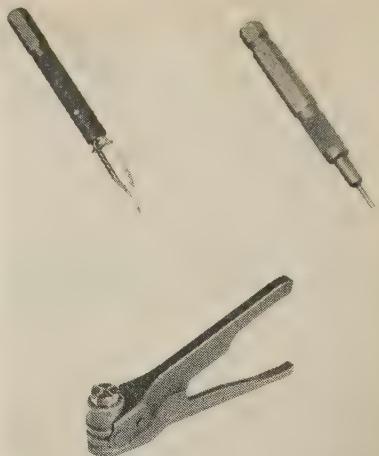
SAFETY... FLEXIBILITY... DURABILITY... ECONOMY... SERVICE FITTED... SERVICE TESTED... SERVICE APPROVED

Illustrated are but a few of the World's most complete line of Line Supports that meet or exceed all applicable specifications and/or requirements. Whatever the application—STANDARDIZE ON ADEL—the leader in completeness of line, service and reliability.

*Reliability*  
**ADEL** PRECISION  
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SPECIFICATIONS ARE AVAILABLE TO AIRCRAFT, MISSILE AND ORIGINAL EQUIPMENT MANUFACTURERS... WHAT ARE YOUR REQUIREMENTS? Direct inquiries to Huntington Division 1444 Washington Ave., Huntington 4, W. Virginia DISTRICT OFFICES: Burbank • Mineola Dayton • Wichita • Dallas • Toronto

Write in No. 127 on Reader Service Card at start of Product Preview Section



**CRIMPING**, insertion, and removal tools (clockwise from bottom) used on snap-in connectors with crimp-type contacts.

method is than soldering.

Tests on a 61-contact connector have shown the snap-in method to be anywhere from four to six times faster than conventional soldering. The fewer contacts there are, of course, the greater will be the time saving of the snap-in design. Moreover, in soldering quality control is up to the operator, while with the snap-in method it is taken care of by the tools—the crimping tool and an equally simple, foolproof insertion tool.

The snap-in contact also shows improved retention. Crimped to a wire, the contact is simply inserted through the rear connector grommet-insert until it spring-locks into positive alignment in the rigid center insert. In this way it is secured against pull forces that present designs normally couldn't take. Initial connector-contact retension forces exceed 25 lb. Up to now, these forces were no more than 15 lb after three soldering cycles.

After 15 insertions and withdrawals, the contact-connector retention in the new DS snap-in connector is not appreciably less than the original guaranteed 25 lb. When rework becomes necessary (because of re-design), the contacts are easily removed with a simple, inexpensive removal tool and are reinserted without any damage.

The new connector, which will withstand a high potential of 2500 V at sea level, still takes a potential of 1000 V ac RMS at 100,000 ft. Such high altitude perform-

more on page 174



CV



## CONVAIR AIRBORNE FREQUENCY MONITORING AND INTERFERENCE CONTROL AIRPLANE USES...



**DATASYNC** is a new breakthrough in data recording capability . . . combining multi-channel Magnetic-Tape with Optical "Panoramic Video" Picture Data, on a single "Datasync" Film for immediate and reliable self-synchronized "Quick-Look" capability, only minutes after recording!

The Convair Division of General Dynamics is producing this Airborne Frequency Monitoring and Interference Control Airplane which carries 51 antennas and uses **Datasync** Equipment to record Panoramic Video optically, plus a "Steno-track" of the intercom conversations between technicians in the aircraft, and between the aircraft and the ground station controls, together with independent recording of time-base signals, etc.

The basic design of this Aircraft is planned for down-range checking at all missile test and launching ranges. It may also be used for checking the functional and electronic environment of DEW Line installations and other defense system ground installations equipped with such components as SAGE "Texas Towers" and "P" Sites.

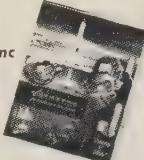
**Datasync** performance and reliability are guaranteed by Berndt-Bach's experience in manufacturing Electronic-Optical Recording Equipment since 1931.

\* Trade Marks of Berndt-Bach, Inc.

are seven Datasync Systems in each Convair FMIC Airplane, which de multi-channel magnetic recording of Filmagnetic data in exact ironism with "scientific shorthand" photographed from oscilloscopes, "Photo-Tape."\*

The "Quick-Look" Datasync System capabilities of combined photo-recording and multi-track magnetic recording, are unexcelled. **Datasync** eliminates the time-consuming editing usually needed to synchronize the magnetic and photographic types of information.

Write for free, full-color illustrated **Datasync** "Catalog of Ideas"...



**DATASYNC**  
A DIVISION OF

**BERNDT-BACH, INC.**

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ELECTRONIC-OPTICAL RECORDING EQUIPMENT SINCE 1931  
Write in No. 128 on Reader Service Card

# Titanium trims DC-8 airframe (equals 5 passengers, or 1/2-ton of freight...for life)

DOUGLAS AIRCRAFT COMPANY, INC., has never built an airplane that failed to show a profit for its operators. Based on the experience of United Air Lines, the first carrier to fly the airplane, the latest Douglas ship, the DC-8 jetliner, indicates it will push this record forward. Here's how use of titanium contributes to the total efficiency of the airplane and what that efficiency means in dollars and cents.

The flyaway airframe of the DC-8 jetliner provides its operators a basic economy almost anomalous in current design: payback on every flight without research or development costs to be amortized. That's how Douglas engineers state the value of titanium in achieving a minimum weight airframe structure.

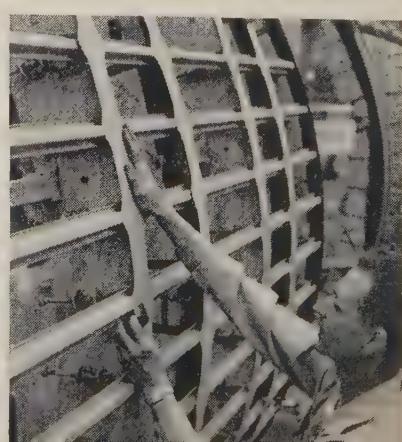
Primarily an aluminum ship, the DC-8 offered few possibilities for weight savings during design. But where weight could be reduced—in pods and pylons, rip stoppers and door doublers—titanium was selected:—600 pounds of commercially-pure grade Ti-75A for pods and pylons; 330 pounds of Ti-6Al-4V titanium alloy grade for rip stoppers and door doublers; 15 pounds of miscellaneous titanium forgings. Metal is supplied by Titanium Metals Corporation of America.

The net result is elimination of a half-ton of needless airframe weight for the 5,000 flights each DC-8 is expected to make during its seven-year write-off.



**TITANIUM ACCESS DOOR**, through which DC-8 engine will be serviced, is installed on the aircraft by two Douglas Aircraft Company, Inc. employees. Pods of the DC-8 have been so designed that titanium will completely seal off any engine fire.

**TITANIUM RIP-STOPPERS** play essential role in Douglas fail-safe approach to airplane construction. DC-8 uses 330 pounds of Ti-6Al-4V alloy titanium produced by Titanium Metals Corporation of America.



# by 945 pounds

TITANIUM ACCESS PANEL which covers engine in DC-8, complete with titanium details, measures 102" by 76" and weighs 80 pounds. Cumulative tolerances are controlled so closely at Ryan that each door is interchangeable with any pod built for a specific airline. 600 pounds of titanium (TMCA grade Ti-75A) are used in DC-8's pods and pylons

interpretations of the value of weight savings include:

DOUGLAS AIRCRAFT: "The 1,000 pounds (of weight saved) are equivalent to five passengers and their luggage for the entire life of the airplane."

UNITED AIR LINES: "At the very least, the weight saved by titanium is equivalent to a half-ton of cargo. At mail rates, this would amount to a potential of \$525 for each coast-to-coast flight."

## Why titanium?

Titanium, with a density of 0.163 lb/cu. in. is produced in lengths equal to or surpassing steel on a strength-weight basis. Resistance to atmospheric corrosion is permanent.

The reliability of titanium has been established with demonstrated clarity. Examples:

DOUGLAS has employed titanium in every commercial transport since its first DC-7, where titanium in firewalls, nacelles and landing gear doors yielded 200 pounds of weight savings.

PRATT AND WHITNEY AIRCRAFT reports that more than one million flight hours have been accumulated by more than 5,800 P & WA JT-3 and JT-4 engines using titanium components without a single failure of any titanium part, either through corrosion or mechanical damage. Both engines have been specified for the DC-8.

Alluding to titanium's reliability as its "sleeper property," W. Stuart Lyman, Principal Metallurgist, BATTELLE MEMORIAL INSTITUTE, made this comment in a lecture in Los Angeles March 19:

"We have talked with metallurgists from three large users of titanium recently. To a man, they reported that once titanium passes receiving inspection, gets fabricated, passes final inspection, and gets assembled into the airplane, it is usually never heard from again."

## titanium competitive in price?

Ryan AERONAUTICAL COMPANY, which fabricates the bulk of the titanium assemblies employed in the DC-8, commands industry-wide respect for its skill of craftsmanship and the attention to detail it brings to every job. Example: To guarantee maximum cleanliness, Ryan's DC-8 final assembly building in San Diego is been so constructed that no doors or windows open in the direction of prevailing winds.

While overlooking no opportunity to impress upon employees' minds that titanium metal costs more than steel, Ryan has developed manufacturing techniques to fabricate titanium prices roughly equivalent to steel's. The spread between "input metal" and completed assemblies is thus drastically narrowed. Metal fabrication costs are, of necessity, far greater than raw material costs.

Highlighting titanium's fabricability is Ryan's production of the access panels which cover the DC-8 engines. These panels — the doors through which engines will be serviced for — are made from three sections of 0.016" Ti-75A, 36" x 72", stretch-formed and welded together to form the skin of the completed door. Details, such as stringers, channels, ribs and frames, are then welded or riveted to the skin. The completed product weighs 80 pounds and measures 102" long by 76" in the curvature. Control of tolerance (cumulative tolerances are 0.005") is so highly developed at Ryan that these massive-looking access panels are interchangeable with any pod built for a specific airline.



## Where does titanium belong?

Titanium metal, built into the DC-8 as a basic design material, has been used in a variety of civilian and military applications in a direct volume-for-volume substitution for heavier materials to capture weight savings sufficient to permit improvements in systems or payload capacity.

Although such weight reduction programs and the attendant dollar value must be viewed in relation to the specific application, titanium's permanent resistance to atmospheric corrosion yields dividends immediately apparent to operators of commercial carriers. It means 8 to 10 trouble-free hours operation each day when maintenance means not only repair costs, but also downtime of expensive equipment.

In pods, pylons, landing gear doors, bulkheads, stringers, and a host of similar parts, titanium's weight savings are measured in *payback*. In projects such as solid and liquid propelled missiles, titanium's weight savings are measured in *payload*.

## Why Titanium Metals Corporation of America?

Titanium Metals Corporation of America, the nation's only organization devoted exclusively to development, production and sale of titanium metal, has wide interest in establishing titanium metal only in those areas where it is of value to you.

The interest arises from the basic belief that a satisfied customer is a steady customer.

This interest is manifested in TMCA's genuine efforts to meet your delivery schedules; to provide you with whatever information you need concerning properties of titanium and manufacture of finished assemblies; and to pass on to you the price advantages gained through TMCA's technological progress.

Whether building new aircraft, or retrofitting operational ships, designing advanced missiles or modifying existing units, you can lick your weight bogey with titanium.



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# RUGGED



## GSE CONNECTORS

Connectors employed in Ground Support Equipment must be rugged and reliable—and easy to handle under any conditions. Fully meeting these particulars, AMPHENOL's popular 89 series GSE connectors are being used in many top missile projects.

GSE connectors are completely waterproof and provide dependable service even when submerged in mud, ice or water. An internal rubber gasket in the cable clamp, a type "W" washer at the mating faces and another washer used with panel mounting receptacles provide assured protection.

To facilitate handling in rough weather, coupling rings are extra-long and heavily grooved. Flats are conveniently located for field-servicing with standard open-end wrenches. Caps & chains are provided for all connectors.

AMPHENOL GSE connectors are available in a large number of standard "MS" inserts. Complete catalog data is available upon request.

AMPHENOL ELECTRONICS CORPORATION

chicago 50, illinois

### Assembly Steps for Soldered and Snap-In Connectors

Soldered Contacts	Snap-In Contacts
(1) Lubricate wire	(1) Strip wire
(2) Thread wire through sealing grommet	(2) Place contact in crimping tool
(3) Strip wire	(3) Place wire in contact
(4) Tin wire	(4) Crimp
(5) Dress soldering iron	(5) Insert contact and wire assembly in connector
(6) Tin soldering iron	
(7) Pre-tin solder pot	
(8) Solder conductor to connector (to avoid destructive temperature build-up, don't solder more than 20 connections in a row)	
(9) Let connector cool	
(10) Bring sealing grommet and nut down into position	

ance is achieved through the entrapment of air while the connector plug is mated to the receptacle and a very low leakage rate during this engagement. Because of these features, the connector can also be immersed in salt water to a depth of 30 ft without any loss of performance.

Vibration tests at 2000 cps and 20-g accelerations have shown no signs of reduced contact pressure, contact opening, or physical damage to any part of the connector. Shock tests up to 150 g also caused no failures. These test results compare favorably with the requirements of Mil-C-26482.

Umbilical, lanyard-type, and rack-and-panel connectors all have been adapted to the new snap-in design with crimp-type terminations and silicone inserts. Coaxial cable terminations, back shell adapters for flexible and rigid conduits, molded cable assemblies, and other special features are available. Increased voltage requirements up to 7000 V have been met.

As we now have suitable standards for corona measurement, the connector engineer can find out where unacceptable corona levels begin and design his units to withstand them. In one current production connector, no objectionable corona occurs at 375 V ac and 60 cycles (RMS) at altitudes up to 110,000 ft. Write in No. 78 on Reader Service Card for more information.—End

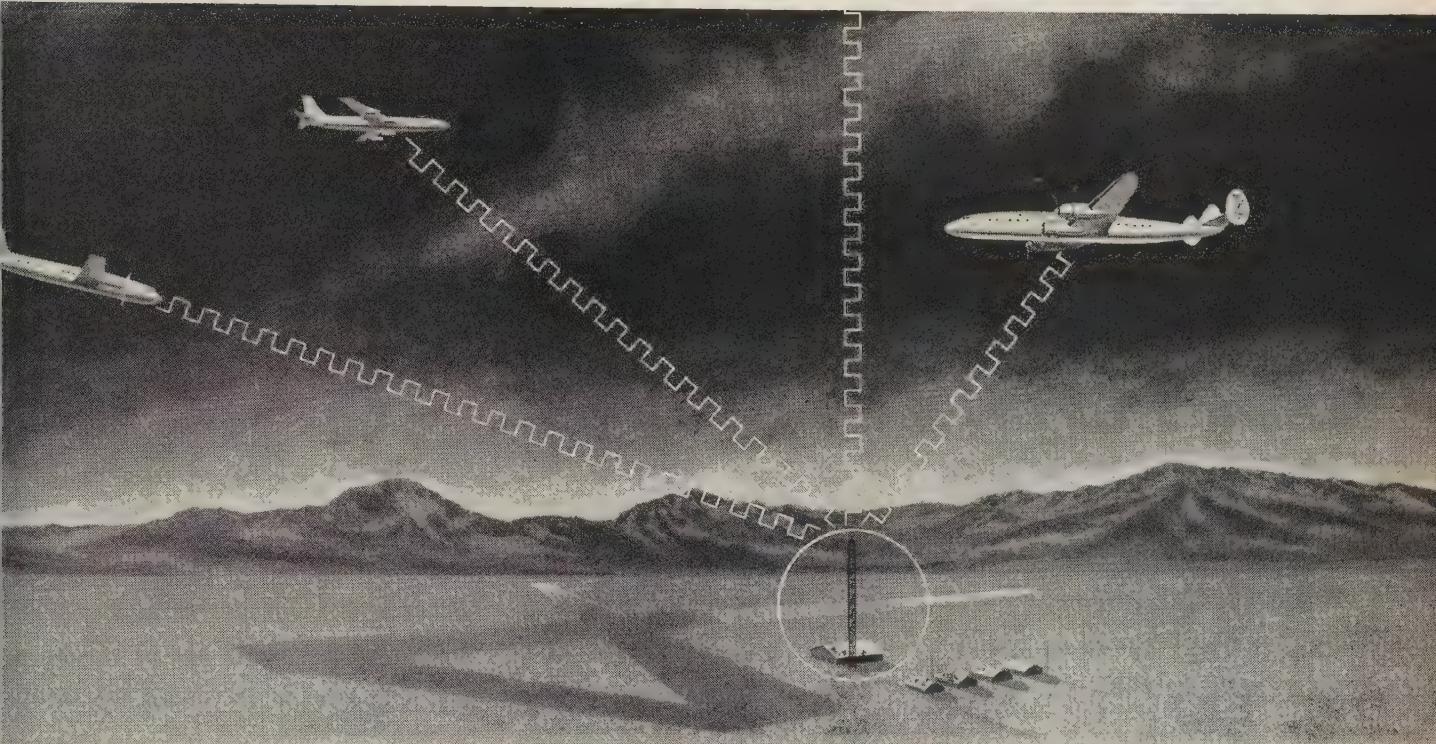
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AMPHENOL

**new  
wings  
for  
words**

# AGACS

*pronounced  
"AJAX"*



AGACS, Experimental Automatic Ground/Air/Ground Communication System is a new concept in Air Traffic Control Communications to meet the accelerated pace of increased air traffic. Primary objectives are efficient usage of frequency spectrum, added safety through increased reliability and reduced burden to pilot and controller, and adaptability to all classes of aircraft. AGACS provides compatibility with existing ground and airborne communication equipment, selective addressing of information, and a minimum number of frequency changes during flight. The system utilizes two-way time division data transfer over existing ground

and air communication links to provide an automatic, mutual exchange of information. The airborne facilities display to the pilot the last significant Air/Ground and Ground/Air message quantities, while the controller may recall from central memory-storage equipment the last Air/Ground and Ground/Air message quantities for display. The AGACS program is still in the developmental stage. In August, 1959, RCA provided initial models of both airborne and ground equipments for the Bureau of Research and Development of the Federal Aviation Agency for extensive experimentation and flight tests.



**RADIO CORPORATION of AMERICA**

DEFENSE ELECTRONIC PRODUCTS

CAMDEN, N.J.

# The U.S. Navy POLARIS, developed by Lockheed: From ocean depths to any target



**Navy's hidden nuclear submarine** (1) launches a solid-propellant POLARIS missile, which erupts from the depths (2), rockets its way into space (3). Plunging earthward minutes later, the warhead of the POLARIS re-enters earth's atmosphere (4) and destroys its target (5).

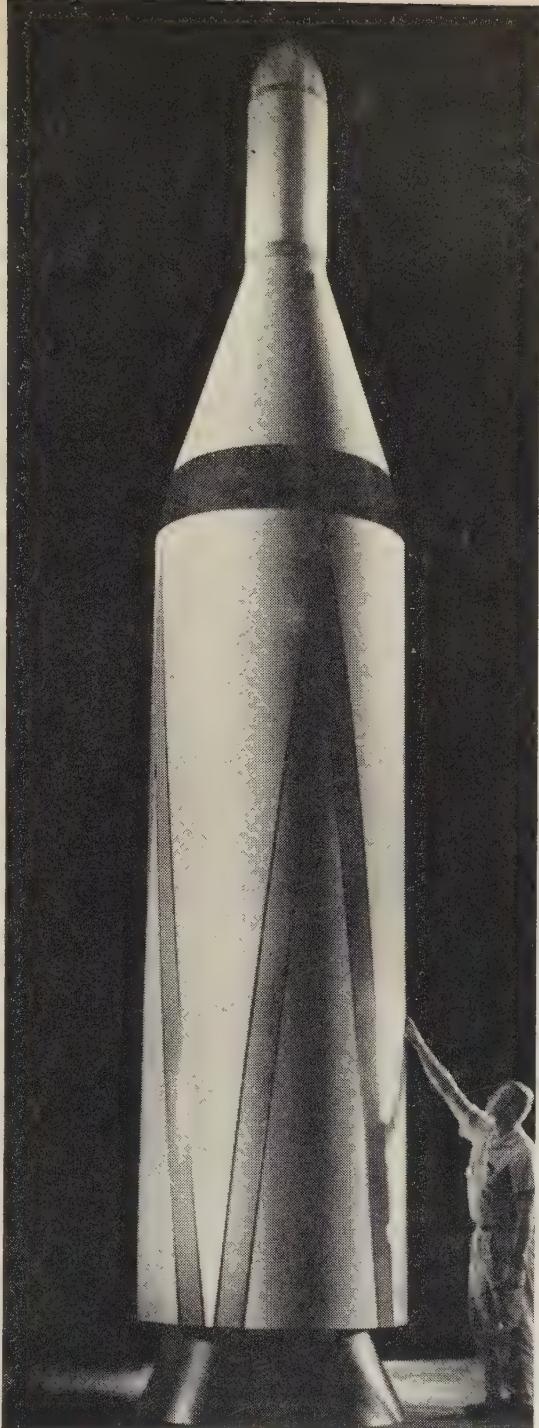
America can breathe easier next year when the Lockheed-developed POLARIS missile goes to sea aboard the Navy's nuclear-powered submarines — far ahead of original schedule. For every significant military target will be within its ultimate range of 1500 nautical miles.

To be an effective deterrent to aggression, a weapon system must be safe from surprise, ready to strike back after any attack. The Navy's POLARIS submarines will be immune to detection as they prowl submerged for weeks at a time. And they'll move the bulls-eye of enemy attack from our

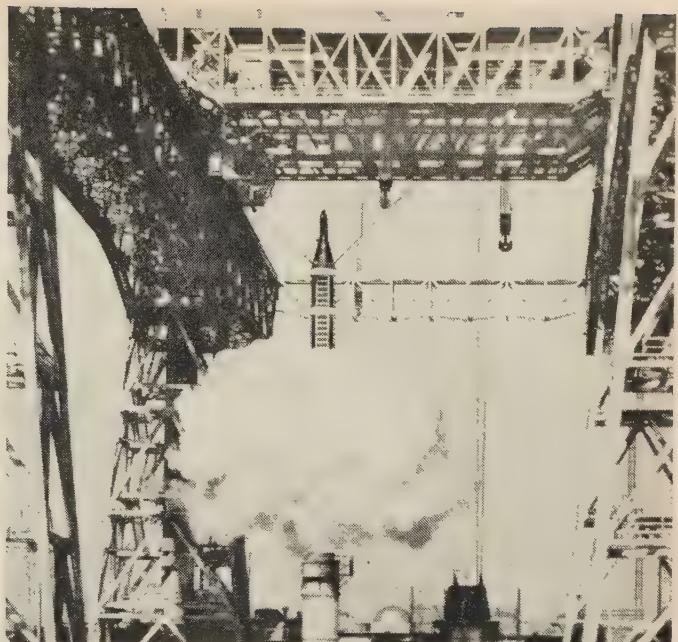
soil to the trackless depths of the sea.

Lockheed's Missiles and Space Division is POLARIS Missile System manager and prime contractor — leader of an industrial team that includes Aerojet-General, General Electric, Westinghouse, and hundreds of other contractors and suppliers, large and small. Close cooperation has brought the POLARIS from blueprint to hardware in record time.

This new combination of nuclear submarine and POLARIS missile will round out the nation's arsenal and give us the flexibility we need for adequate defense.



**POLARIS** is much smaller than other U.S. ballistic missiles of the same range, thanks to new miniaturization techniques developed by Lockheed scientists. This permits each nuclear submarine to carry 16 missiles.



"Operation Sky-Catch" is apt name for this huge overhead assembly. It catches POLARIS test vehicles in mid-air after test launchings. This prevents damage to components and gives more accurate instrument readings, thus saving time and speeding development. Tests are conducted jointly by U. S. Navy, Westinghouse, and Lockheed.



4,000-acre test base in the Santa Cruz Mountains of California is where Lockheed's Missiles and Space Division puts completed POLARIS missiles through simulated flights that prove the propulsion and guidance systems before actual flights of development missiles.

# LOCKHEED

JET TRANSPORTS • JET FIGHTERS • JET TRAINERS • COMMERCIAL & MILITARY PROP-JET TRANSPORTS • ROCKETRY  
BALLISTIC MISSILE RESEARCH & DEVELOPMENT • WEAPON SYSTEM MANAGEMENT • ANTI-SUBMARINE PATROL AIRCRAFT  
NUCLEAR-POWERED FLIGHT • ADVANCED ELECTRONICS • AIRBORNE EARLY-WARNING AIRCRAFT • AIRPORT MANAGEMENT  
NUCLEAR REACTOR DESIGN & DEVELOPMENT • GROUND SUPPORT EQUIPMENT • WORLD-WIDE AIRCRAFT MAINTENANCE



# Sharp new eye for navigation

**S**HARPEST new "eye" for flight is the Ryan C-W Doppler navigator. Based on the advanced development of continuous-wave radar, this system of electronics "intelligence" has been pioneered by Ryan and the U.S. Navy for navigation at all speeds. It tells pilots how to fly to any spot on the globe, with speed and precision, and lets them know exactly where they are at all times.

With the Ryan navigator, military aircraft and jetliners can fly a new "electronic skyway" which provides precise separation between planes and conserves time and fuel. And, because RYANAV systems work right down to ground and sea levels, these advantages accrue at take-off, climb-out, descent and landings, as well as enroute.

The Navy has selected RYANAV for installation in six major types of naval aircraft. They are already in squadron use in the Navy's first all-weather anti-submarine helicopters and are being installed in Army aircraft and helicopters, for low-level "nap of the earth" operations.

Reasons for such wide and versatile use are found in the unique features of RYANAV systems: They are the lightest, simplest, most reliable, most compact of their type. They are setting new standards of accuracy, freedom from adjustment, and ease of maintenance... opening new areas of navigational, guidance, and orientation applications. Ryan electronics engineering assistance is available upon request, to those who wish to explore these areas.

*Ryan's rapid growth in electronics is creating new opportunities for engineers and technicians*

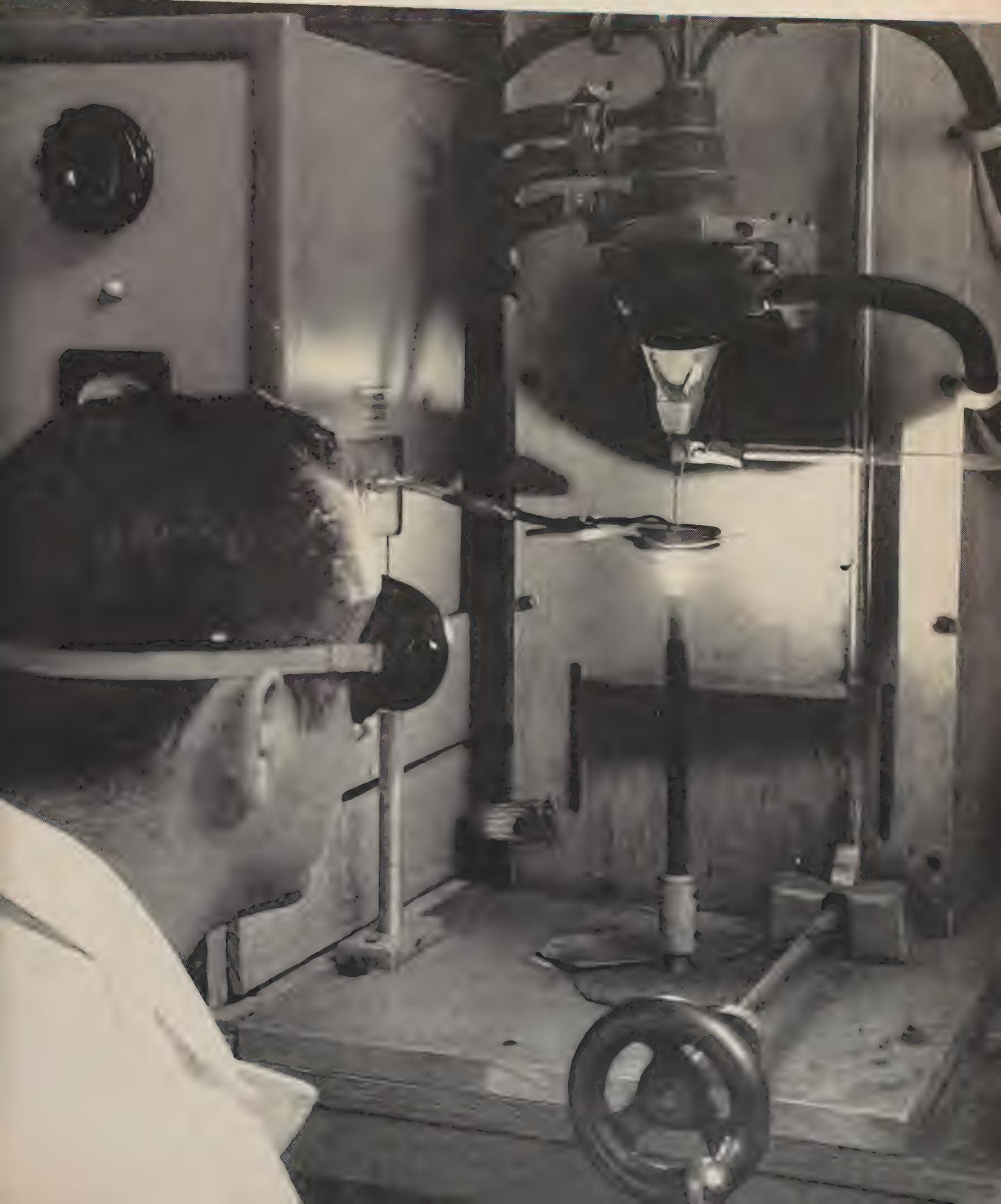
**RYAN BUILDS BETTER**

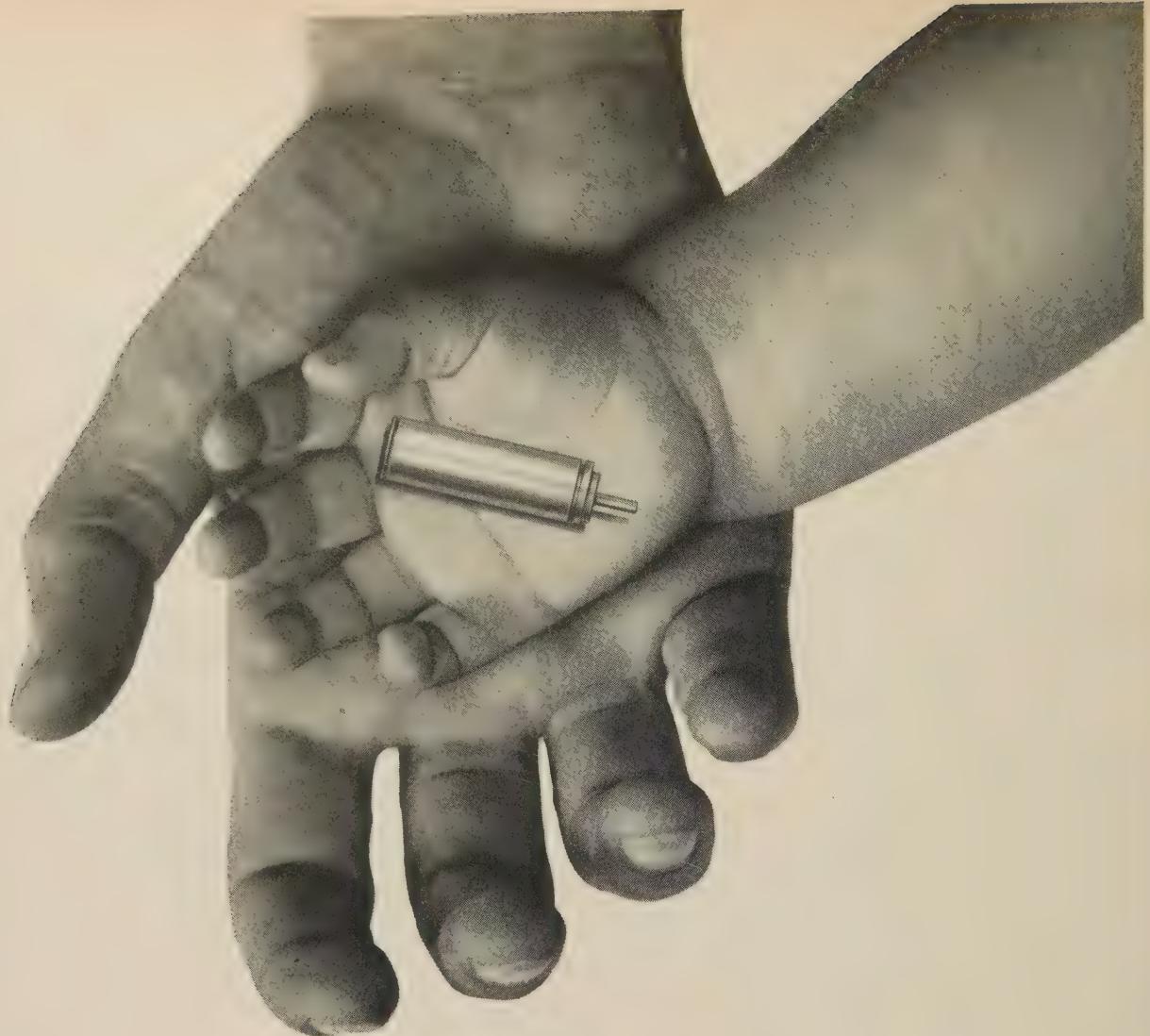
ELECTRONICS DIVISION

**Ryan Aeronautical Company, San Diego, Calif.**

Write in No. 132 on Reader Service Card at start of Product Preview Section

*space* / *aero* Electronics





## **pared down to fit where others can't... size 5 motor generators**

Size 5 Motor Generators are now a reality! Servo engineers working against extreme space and weight limitations can specify the ultimate in miniaturization—*Daystrom Transicoil*. Weighing a mere 1.1 oz, these Size 5's develop a minimum stall torque of 0.11 oz-in and have a free speed of 10,000 rpm. Units are available for 400 cycle operation with 26 or 33 control phase winding. The control phase is split for operation directly with transistor amplifiers.

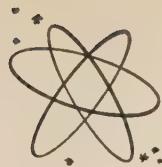
Complete specifications with drawings and graphs of performance characteristics are yours for the asking. Other types and sizes of motors and motor generators are also available. And be sure to get complete details on our new synchro line. Daystrom Transicoil, Division of Daystrom, Inc., Worcester, Montgomery County, Pa. Phone: JUNO 4-2421. In Canada: Daystrom, Ltd., 840 Caledonia Rd., Toronto 19, Ont. Foreign: Daystrom International Division, 100 Empire Street, Newark 12, N. J.



**DAYSTROM TRANSICOIL**  
DIVISION OF DAYSTROM, INC.

*Representatives in Canada and Other Foreign Countries*

**Write in No. 133 on Reader Service Card at start of Product Preview Section**



## space/aero electronics intelligence

SELF-HEALING electronic computer was proposed to the military by Texas Instruments telemetry engineers. It would repair itself in flight by sensing module failures and electrically replacing defective units with spares.

ELECTRONICALLY SCANNED microwave antenna that can scan in both azimuth and elevation planes was developed by Hughes Aircraft. It is an array of separate radiators each of which has a ferrite elements inserted in its waveguide. Inertialess scanning is achieved by varying the dc control fields of the ferrites, thus shifting the phase of the signals radiated from each element.

The temperature of the ferrites has to be held within  $\pm 1$  deg C of the 50-deg C operating temperature. Brass waveguide walls are used as a heat sink to dissipate the  $I^2R$  losses through the ferrite. Hughes researchers hope to find eventually a ferrite compound whose saturation magnetism is insensitive to temperature changes.

BY PROPER PROGRAMMING, the ferrite array can radiate  $n$  beams in  $n$  directions to track  $n$  targets simultaneously. There is no limit in scan rate, says Hughes, other than the range of the radar (since it takes a finite time for the radar signal to go out and come back). Insertion loss of the developmental antenna is one decibel. With a low-noise ferrite, an 0.25-db insertion loss could be attained, Hughes claims.

### Litton "barratron" is high-powered generator of non-coherent white noise

BOON TO countermeasures designers is the new "barratron" tube developed by Litton's Electron Tube Div. It is a high-powered generator of non-coherent white noise. According to Litton, it has at least 10 times the effective jamming power of magnetrons.

Both fixed and tunable versions have been made. The fixed-tuned models, claims Litton, for the first time provide enough power for full-spectrum barrage jamming in an airborne ECM transmitter.

ADVANTAGE of the barratron over the magnetron is that the new tube's non-coherent white noise contains more frequency components, so that its spectrum is spread at a high level across a broader band. Tunable versions are physically and electrically interchangeable with tunable magnetrons.

DISPLAYING 3-D information is going to be a problem. New concepts in display techniques will be needed to present the azimuth, elevation, and range data from its new radar and similar designs, says Hughes. So far no suitable schemes have been developed.

Litton has 18 types of either hydraulically or mechanically tunable barratrons covering the UHF to high frequency microwaves.

MONOCRYSTALLINE FERRITES were grown at ITT Labs by a "flameless-fusion" process. A thermochemical reaction using high frequency radio energy traveling in a small metal loop is used to generate high temperatures. Specially prepared powder is sifted through the loop and is heated on passage to about 2000 deg F, says ITT. When cooled under properly controlled conditions, it coalesces into a monocrystal.

Previously, claims ITT, ferrite monocrystals have existed only in nature—in minute quantities and sizes. Artificial synthesis of single crystals was difficult. The ITT process should open the doors to a lot of interesting experiments on crystalline structures.

### Copters could fly "remembered" course with Dolphin

DOLPHIN SYSTEM developed by Ryan Electronics combines Ryan's standard copter Doppler navigator, a hovering device, and a dead-reckoning plotting instrument. It lets a copter to fly a "remembered" course—the copter can go out and return to its point of departure.

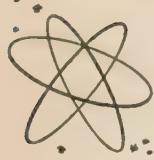
The new system should prove especially valuable for anti-sub work.

MINUTE X-BRAND radar receiver was developed for semi-active-radar-guided version of the

more on next page



Cover story — New technique developed at ITT Components Div. produces fine semiconductive crystal from cheap  $Fe_2O_3$  powder. Radio energy charges metal loop and heats powder. This sifts via glass tube through loop, becoming crystal on cooling.



## space/aero electronics intelligence

Sidewinder. Just like the Falcon, another air-to-air missile, the Sidewinder now will have IR and radar versions.

NEW DIRECTIVE signal source for long range sonar is being worked on by Acoustica Associates under Office of Naval Research sponsorship. In a developmental model, a 10-kc signal is coupled onto a long, thin rod via a driving transducer. The rod radiates sound energy into the water by means of axially symmetrical waves travelling in the direction of the axis. Because of the design of the rod, the phase velocity of a compressive wave equals the acoustic velocity of the surrounding medium.

As described by D. R. Church, Acoustica's director of research, in a paper at the recent Western Electronics Convention (Wescon) the unit is 13 ft long and has a directivity index of over 20 db, an efficiency of over 60 per cent, and a power handling capability of over two kilowatts. The power-weight ratio of the model exceeds 30 W/lb. Church likens the sound source to a highly directional end figure array.

### Domain-domain interaction is foreseen for magnetic digital computer

THE ELECTRONIC LAB will look more and more like a chemistry lab as we increase our semiconductor knowhow, predicts Ralph F. Redemske, vice-president in charge of research for Servomechanisms. At Santa Barbara, Calif., Servomech's materials research group (headed by Redemske) is working on refractory materials with useful electric properties.

In the course of its work, the group has discovered a way of harnessing magnetic domains. As a result, it is now thinking of a magnetic digital computer in which logic is gotten by domain-domain interaction. The interaction would produce a bistable situation much as does an electronic flip-flop. The computer would have no interconnections—it would be a thin sheet of iron-nickel.

SOME OF the computer's basic elements are already working at the Santa Barbara lab. According to Redemske, the logic element would be a high speed device—flip time would be between 0.3 and one umsec. The same interaction phenomenon but a different film would be used for the memory.

The development of the magnetic computer,

says Redemske, would bypass the fully transistorized digital computers now in development. Burroughs, IBM and National Cash Register, are also active in magnetic-computer research. Servomech feels its contribution in this field lies in the harnessing of the magnetic domains.

### GE is working on super-secret second Red Eye

TWO RED EYES? In addition to the recently announced Red Eye "bazooka"-type IR-guided Army missile in R&D at Convair-Pomona, there is a super-secret project being worked on by a General Electric group at Santa Barbara, Calif., that is also called "Red Eye". The two "Red Eyes" apparently are not related.

EMERSON'S APN-100 FM-CW radar altimeter may be the answer to our need for a low-level absolute height indicator. Adaptable to aircraft, copters, missiles, and drones, it has these characteristics: range—0-3000 ft; accuracy— $\pm 2$  ft from zero to 100 ft and  $\pm 2$  per cent of correct terrain clearance gradually increasing to  $\pm 5$  per cent from 100 to 500 ft; rate of climb and dive—lag by  $0.35V$  ft, where V (in fps) is the vertical component of the climb or dive; frequency range—4300  $\pm 50$  mc; transmitter power output—300 mw minimum; modulation capability—40 mc; weight—12.5 lb; dimensions— $8\frac{1}{8} \times 3\frac{7}{8} \times 17\frac{3}{4}$  in.; mounting—flush to airframe.

### TIMM multivibrator circuit demonstrated by GE at Wescon show

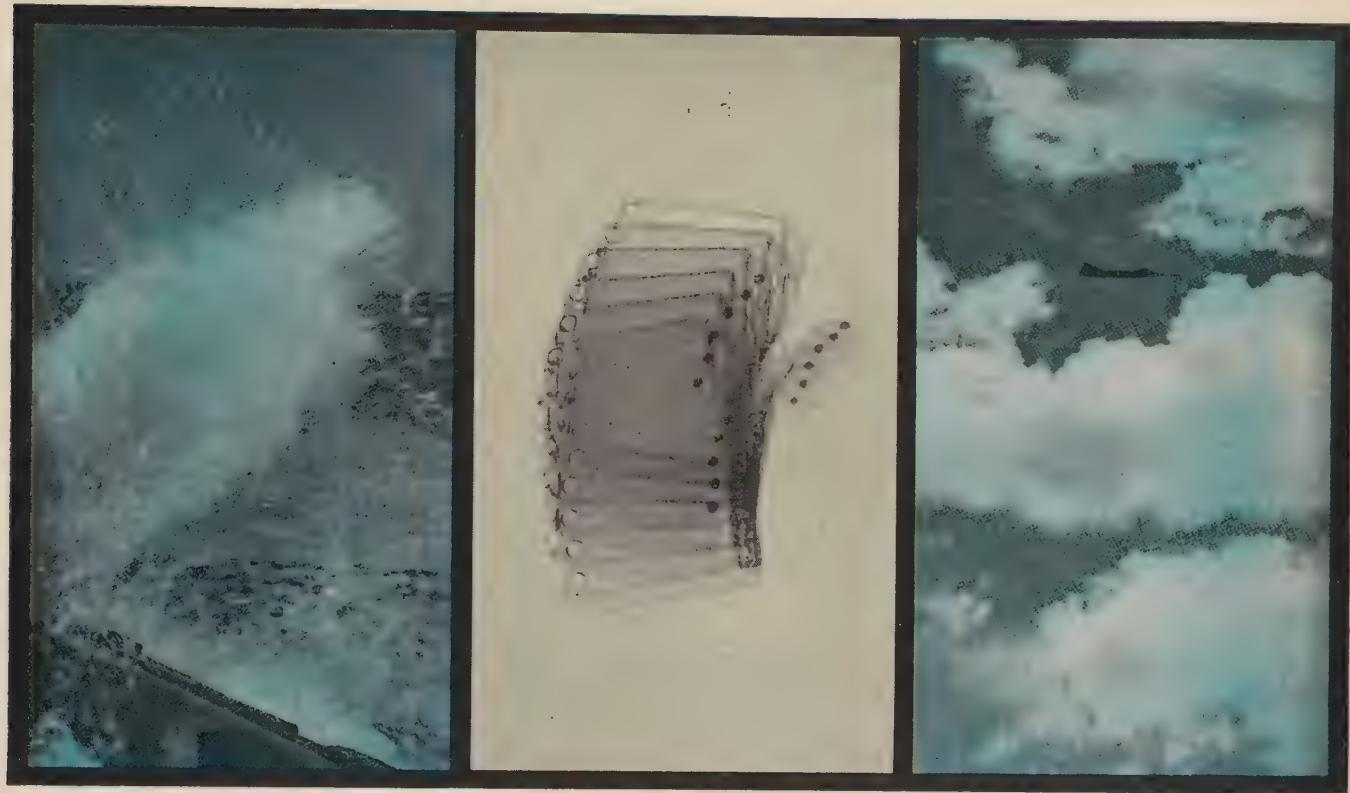
TIMM (Thermionic Integrated MicroModule) operating circuit was demonstrated to the industry for the first time at the Wescon show. General Electric's Receiving Tube Dept., which developed the concept, had a multivibrator circuit working inside a 580-deg-C-ambient oven. The circuit consisted of two metal-ceramic triodes (both heaterless), four ceramic resistors, and two ceramic capacitors. It drew two milliamperes from a 90-V dry battery.

"WORLD'S TINIEST tape recorder" is Leach's claim for its  $10\frac{1}{2}$ -oz, 14 cu in. unit. Designed for missile and satellite use, the recorder can take 2000-g shocks. It records on 1-16 channels on a continuous tape that will play back. Power consumption is  $1\frac{1}{2}$  W.

more on page 184

# NEW—RUGGED "MIL-SPEC" CIRCUIT BREAKER

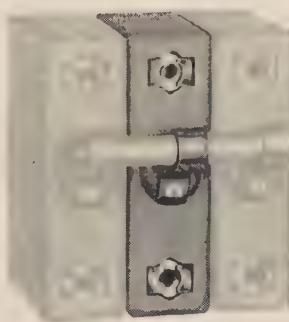
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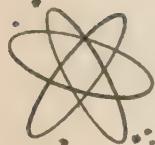
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October 1959

*Circuit breaker*





The device can record at speeds from  $\frac{1}{2}$  to 60 ips. It contains 10 ft of one-inch-wide mylar-coated tape.

THREE-DIMENSIONAL airborne radar designed by Bendix-Pacific consists of a 16.5-kmc transmitter, a phase-limiting antenna with dual slot arrays, a local oscillator, two IF amplifiers, and an IF phase detector. A combination of slot-array phase limiting and single-pulse operation provides quick and full elevation and range information with reduced antenna scanning—no elevation scan is needed, and horizontal scanning is needed only for azimuth data.

The set radiates a 0.1-usec 50-kw peak pulse at 2400 prf. It is designed for terrain clearance and radar mapping. An altimeter function can be added by installing another receiver, a time-measuring device, and two antennas.

## Standards situation is deteriorating as aerospace projects forge forward

STUDY OF MEASUREMENT PROBLEMS by Sperry Gyroscope for Aerospace Industries Assn. and run in cooperation with USAF and the Bureau of Standards shows the needs of advanced space projects are outstripping the industry's measurement capabilities. Ten years ago, Sperry found, most precision measurements concerned only the dimensions of objects. Today, 85 per cent of all precision measurements involve electric or electronic quantities. For many of these, we lack adequate national standards.

The worst measurement headaches, the study showed, crop up in radar, missiles, and computer, navigation, and communications systems. Critical problems are posed by the lack of:

- standards of force for measuring the thrust of large rockets,
- a standard daylight for calibrating astronomical star trackers,
- microwave power standards for calibrating radars.

AMONG the recommendations of the study were:

- adoption of nationally uniform methods and procedures for transferring calibrations from primary standards to the working standards used by industry and military.
- expansion of NBS's calibration services,
- a program for better training and communications in the field of measurements.

TEN VITAL measurement categories were covered in the Sperry study: dimensional; optical; temperature and humidity; shock, vibration, and force; microwave; radio frequency; electric (ac, dc, audio, and video); pressure, vacuum, and fluid flow; infrared; and radiological. The most significant specific problems found by Sperry included:

- *Radio Frequency*—measurement of CW voltage, power, and attenuation on unbalanced lines and of impedance, as well as the calibration of sine-wave signal generators;
- *Microwave*—measurement of attenuation in the 0.1-45-db region, of VSWR, and of unmodulated power and average pulse power;
- *Electric*—measurement of ac voltages from one to 300 V, of the dc resistance of standard resistors, of dc voltages with digital voltmeters, and of the dc voltage ratios of standard voltage dividers;
- *Infrared*—required accuracies not yet established, and measurement problems lie in the future, according to Sperry.

## Over 60 companies involved in bids for contract on Sage's ALRI system

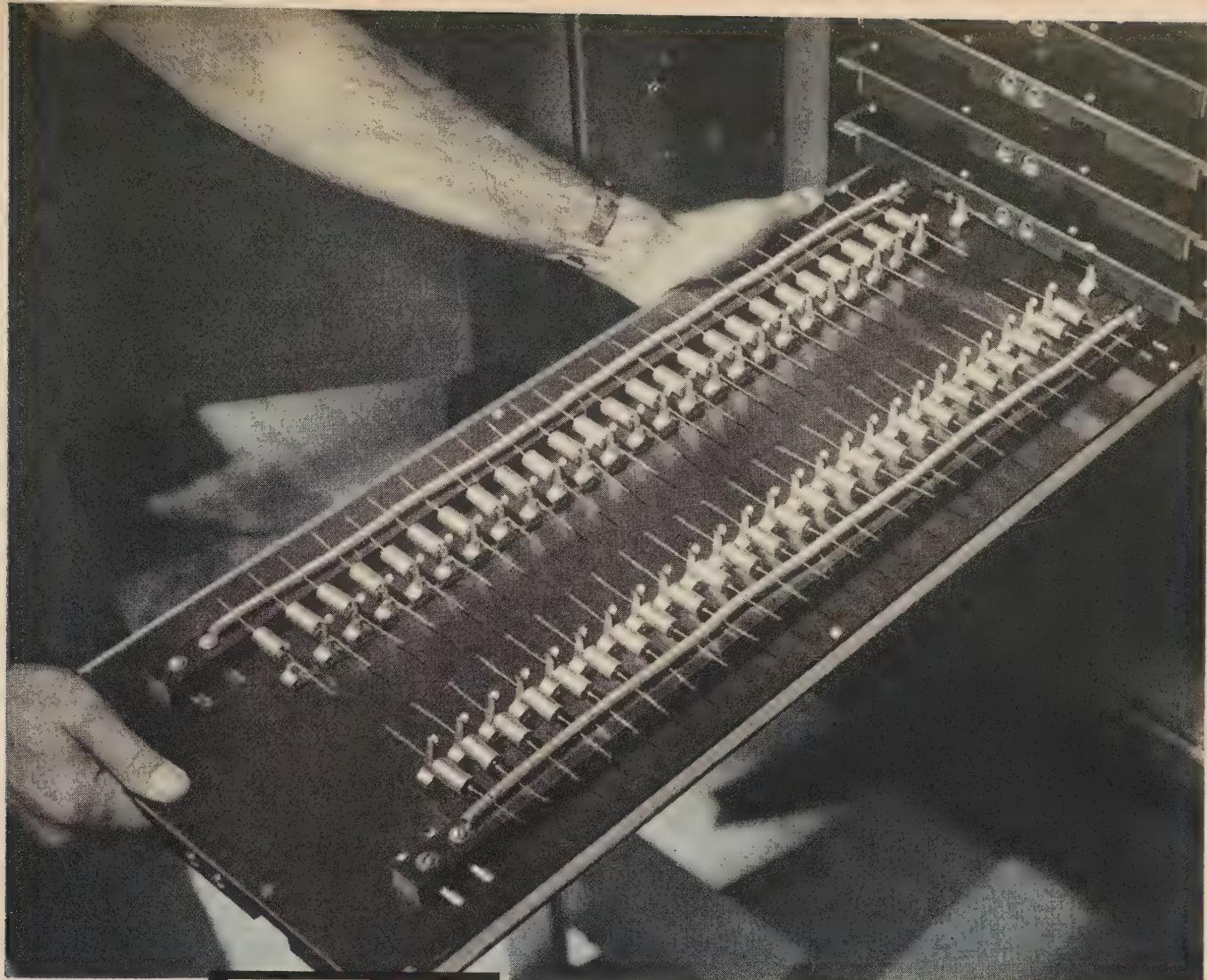
CONTRACT for "Airborne Long Range Input" (ALRI) to Sage is expected to be awarded this month. It's estimated to be worth roughly \$100 million.

Some 60 companies, including teams headed by Convair, GE, Hazeltine, Litton, and Lockheed, were present at a bidder's conference in Dayton, Ohio.

The project would include Lockheed's RC-121D as the early-warning aircraft. Radar data would be sent via a data link to Sage centers. A number of the bidding companies reportedly proposed the use of RCA's one-kilowatt UHF airborne amplifier to transmit the UHF carrier modulated with the radar data.

ALRI will close one of the links still remaining open in the Sage system.

MAJOR R&D SUBCONTRACT on the Minuteman system's launch-control complex went to RCA. RCA's job will be to develop the cable-microwave networks that will link the firing silos and the launch-control centers. Fitted with nuclear warheads, the three-stage, solid-fuel ICBMs will be stored in the hardened underground silos on an instantaneous alert.



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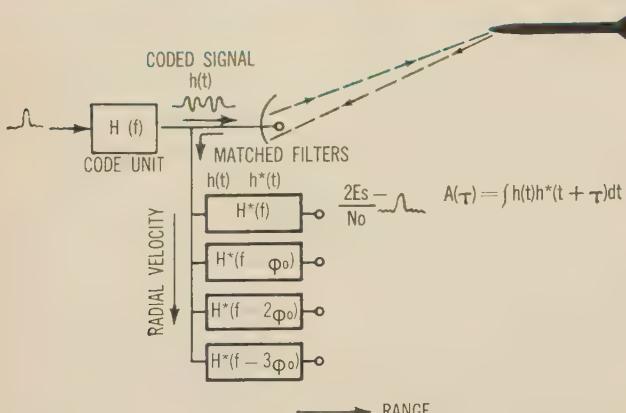
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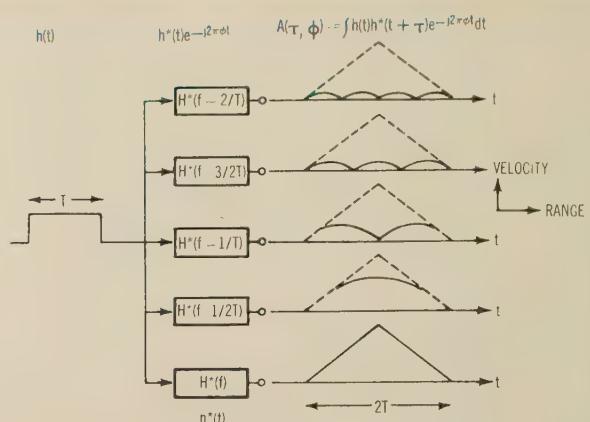
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**FIGURE 1:** Matched-filter radar (left). Linear filters encode and decode a pulse signal. Matched filters max-



imize ratio of response to the signal to response to noise. Right: Resolution of single-tone pulse.

# Waveform design

## for tomorrow's radars

Simple pulse waveforms for radars appear to be on their way out. Instead, we're going to more complex forms with more information content. These may add to the design problem, but they can also give results that once could be gotten only by brute-force techniques.

by Sidney Applebaum and

P. W. Howells, Advanced Engineering Section,  
Heavy Military Electronics Dept., General Electric Co.

**W**HEN YOU DESIGN an early-warning radar you should do everything to increase detection reliability, reduce susceptibility to jamming, and get more range and velocity information on a single-pulse basis. You can easily see what these improvements depend on: Target detectability is limited only by the *total energy* of the radar return, range resolution by the return's *bandwidth*, and velocity resolution by the return's *duration*.

A properly encoded waveform with extent in both time and frequency therefore offers two advantages over the normal radar pulse:

- Signal energy may be increased by increasing duration rather than peak power.

(1) Heavy Military Electronics Dept., General Electric Co., Cert St., Syracuse, N.Y.

- The extent of the signal in frequency and in time (i.e., its range and velocity resolution) may be controlled independently. In the normal radar pulse, better range resolution is bought at the cost of poorer Doppler resolution and vice versa.

Before waveform coding can be used, two problems must be solved:

- You must choose a waveform that can provide the required range and velocity resolution. This choice is as fundamental to the design of the radar system as is the choice of the antenna.

- You must find a feasible means of encoding the signal and then decoding it so that all the information it contains is extracted. This field of radar signal design and processing is still largely unexplored, despite considerable work done at Lincoln Labs, GE, and elsewhere.

A search radar usually has to get its target information under adverse conditions—in the presence of noise, ECM, or multiple targets. Optimum detection of the signal under such conditions requires receiver filtering that is matched to the radiated signal. It is well known, for example, that, with a normal radar pulse, IF bandwidth should be matched to pulse length for optimum noise performance.

### RF pulse used to form signal

Figure 1 shows a matched filter system in which linear filters are used both to encode and decode a coded pulse signal. To form the coded signal, a narrow RF pulse is supplied to the encoding filter. If we assume the input pulse spectrum is flat and linear in phase, we can represent the coded signal output by either the time response  $[h(t)]$  or the frequency response  $[H(f)]$  of the coding filter. This filter can't, of course, increase the bandwidth of the input spectrum—all it can do is re-arrange it—so the coded signal's bandwidth is the same as that of the input pulse. How many and what types of coded signals can be produced in this way depends mainly on the patience of the filter designer. Long, phase-modulated pulses, pulses with linear frequency modulation, and even sinusoidal FM signals are possible.

The coded signal return from a target is fed to the matched decoding filter, whose frequency response is the complex conjugate of the signal (or the encoding filter). The matched filter then has the characteristic  $H^*(f)$ . Its amplitude response is the same as that of the encoding filter, while its phase, or time delay, characteristic is the mirror image of the encoding filter.

This is only logical: If the encoding filter has a time delay characteristic that disperses the original pulse, the matched decoding filter should have identical negative delay variations to gather the pulse together again. If the encoding filter emphasized one part of the spectrum more, the matched filter should recognize this by weighting the strong part of the signal return more heavily than the weaker, noisier part.

The output of the matched filter is the product of the signal spectrum  $[H(f)]$  and the filter's own frequency response  $[H^*(f)]$ . In time, the output is given by the convolution of the signal with the impulse response of the matched filter:

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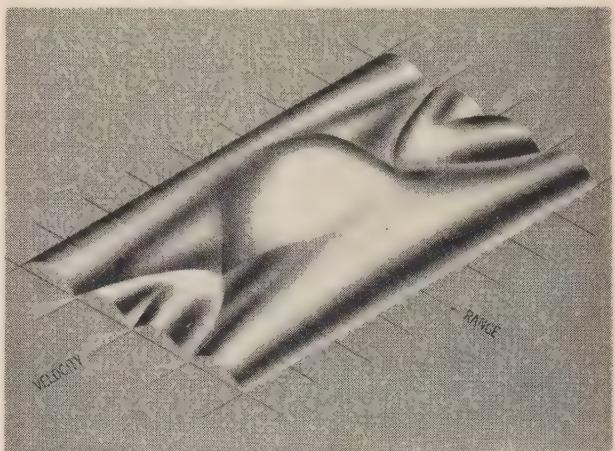
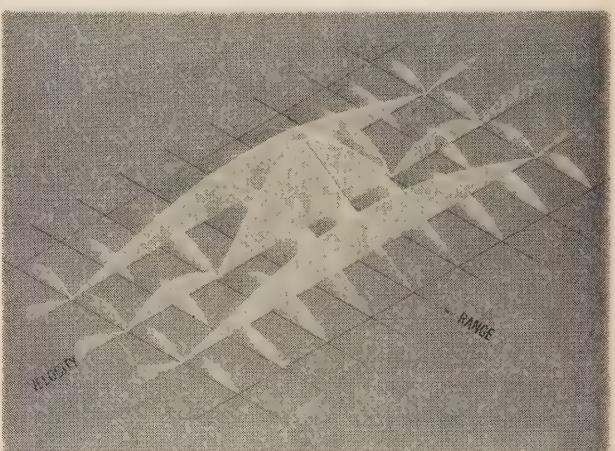
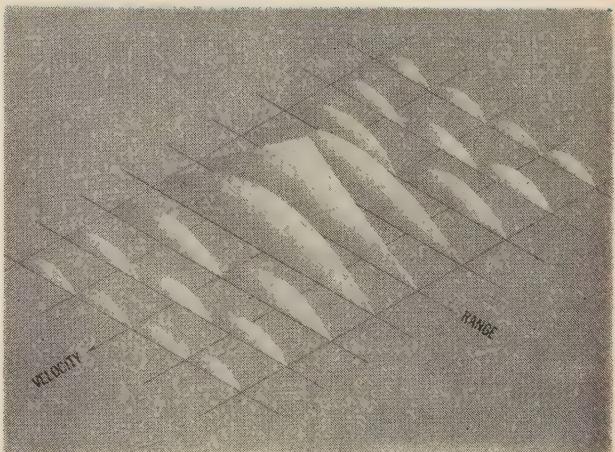


FIGURE 3: Ambiguity function of a single-tone pulse.

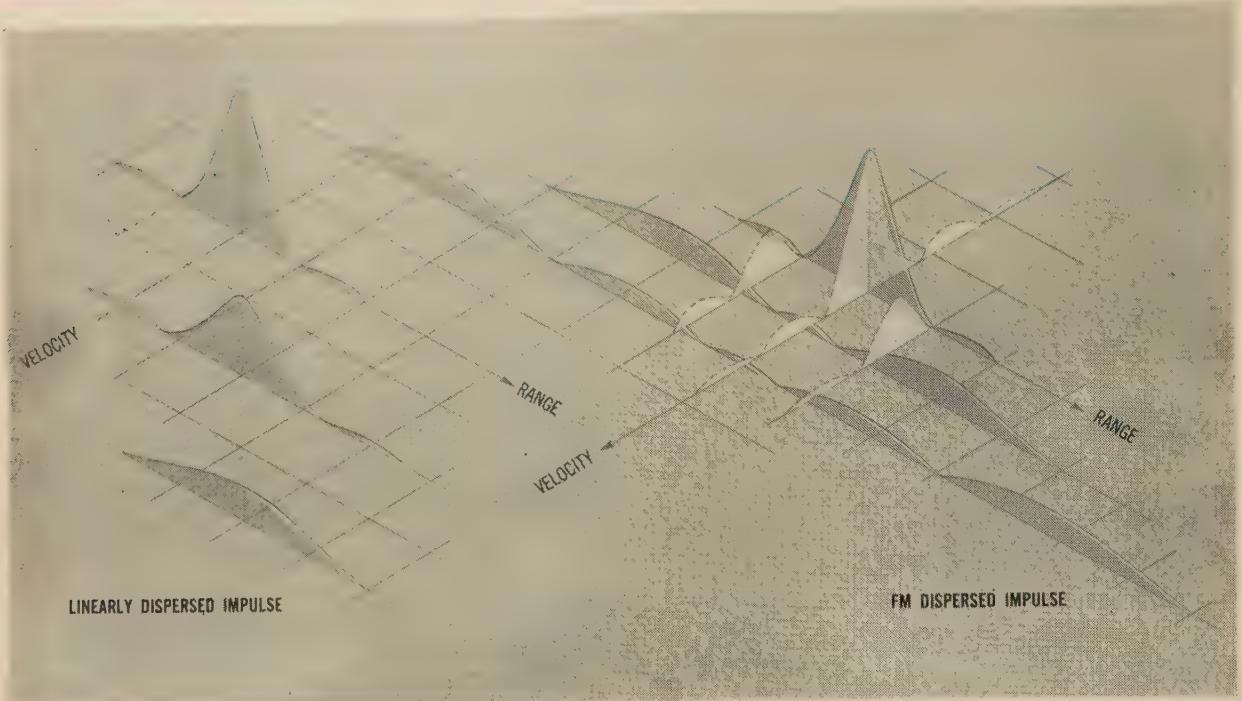


FIGURE 3: Power ambiguity function.

$$(1) \quad A(\tau) = \int h(t) h^*(t + \tau) dt,$$

Note that this output generally is *not* the original input pulse<sup>2</sup>—it is the auto-correlation function of the coded signal [ $h(t)$ ]. It will, of course, be shifted to a time corresponding to target range.

We can say that the *matched filter cross-correlates the signal return against the transmitted signal waveform*. For good range resolution, the coded signal should have a sharp autocorrelation function in time, with a minimum of “side lobes.” Since the minimum effective duration of the autocorrelation function is the inverse of the bandwidth of the coded signal, bandwidth, as we’ve noted, is what limits range resolution.

### Jamming threat can be reduced

The signal-to-noise ratio at the matched filter output can be shown to be:

$$(2) \quad S/N = 2E_s/N_o,$$

where  $E_s$  is total energy in the coded signal return and  $N_o$  the average noise power *per cycle of bandwidth*.

*Equation 2* leads us to two interesting conclusions:

- We can increase the range-velocity resolution of the signal as much as we want without affecting its detectability, which depends only on its total energy.
- As the time-bandwidth product of the coded signal increases, the signal’s vulnerability to jamming de-

(2) In special cases, the matched filter output may be the same as the input pulse. For example, if the coding filter has a frequency response that is flat in amplitude, then its conjugate will also be its inverse. The result of passing the input pulse through the coding filter and then through its inverse matched filter will obviously be the same pulse output. This is true in the case of the FM signal.

creases. For example, assume that  $N_o$  is produced by a jammer that matches the bandwidth ( $W$ ) and duration ( $T$ ) of the coded pulse. The total jammer energy competing with the coded pulse then is:

$$E_j = N_o W T \text{ watt-seconds.}$$

We therefore can rewrite *Equation 2* as:

$$(3) \quad S/N = (2E_s/E_j) WT.$$

If the coded pulse has a duration fifty times longer than that of the original impulse (but the total energy is the same), it will require fifty times more energy on the average to jam it with a jamming signal that has the correct duration and energy spectrum but is unmatched in phase.

If the coded signal return has undergone a Doppler shift due to target velocity, the decoding filter must be shifted in frequency by the same amount. When a range of Doppler frequencies is expected, a whole bank of matched filters (or its equivalent) must be provided, with one filter for each Doppler frequency of interest (*Fig. 1*).

You can study the overall response of such a filter bank to a signal by considering what happens when a coded signal is supplied to a matched filter detuned by difference frequency  $\phi$ . Let the signal still be expressed as  $H(f)$ . Instead of  $H^*(f)$ , the matched filter frequency response now is  $H^*(f + \phi)$ , and instead of  $h^*(t)$ , the impulse response is  $h^*(t)e^{-j2\pi\phi t}$ . As before, the filter output is the convolution of the signal with the impulse response of the filter:

$$(4) \quad A(\tau, \phi) = \int h(t) h^*(t + \tau) e^{-j2\pi\phi t} dt.$$

Since the output is a function of both range ( $\tau$ ) and

velocity ( $\phi$ ), it may be called the combined autocorrelation function of the signal. The behavior of this function as the relative frequency shift  $\phi$  is varied determines the velocity resolution capability of the signal.

This point is also made clear in *Figure 1*. The signal is assumed to be a simple rectangular pulse of duration  $T$  and with a  $\sin x/x$  spectrum whose zeros are spaced at intervals of  $1/T$  cycles. The filter bank is assumed to have filters spaced by  $1/2T$  cycles. The bottom filter is tuned to the center frequency of the pulse, so it gives the correct output—the triangular waveform that is the autocorrelation function of the square pulse. The next filter, tuned below (or above) the signal frequency by  $1/2T$  cycles, yields a rounded pulse whose peak is 0.6 of the correct response. In the presence of noise, this difference might be just perceptible, so the Doppler resolution would be  $1/T$  cycles, the spacing between the two filters whose response is perceptibly different from the correct response. As shown in *Figure 1*, the response of the matched filters falls off as they are tuned farther from the signal frequency.

### Response depends on coded signal

Since the structure of each matched filter is determined entirely by the coded signal, the response of each filter to a valid echo depends only on the form of the coded signal. The time variations of the response from a single filter indicate the signal's range resolution, and the variations in the response with frequency—i.e., from one filter to the next—indicate its Doppler resolution.

To visualize the quality of the signal, we can construct the surface shown in *Figure 2*, in which the matched filter responses are plotted vertically on a base plane that has range or time as one axis and velocity or Doppler shift as the other. The filter bank of *Figure 1*, of course, provides only the contours of the surface at the fixed Doppler frequencies to which the filters are tuned. The complete surface is described by the time response of a single matched filter as it is slowly tuned past a coded signal of fixed frequency (or as the signal is tuned past a fixed filter).

We can find these time responses analytically by solving *Equation 4* for  $A(\tau, \phi)$ , using a number of different values for the frequency shift ( $\phi$ ). If the signal is more conveniently expressed in terms of its frequency spectrum, we can use the equivalent form:

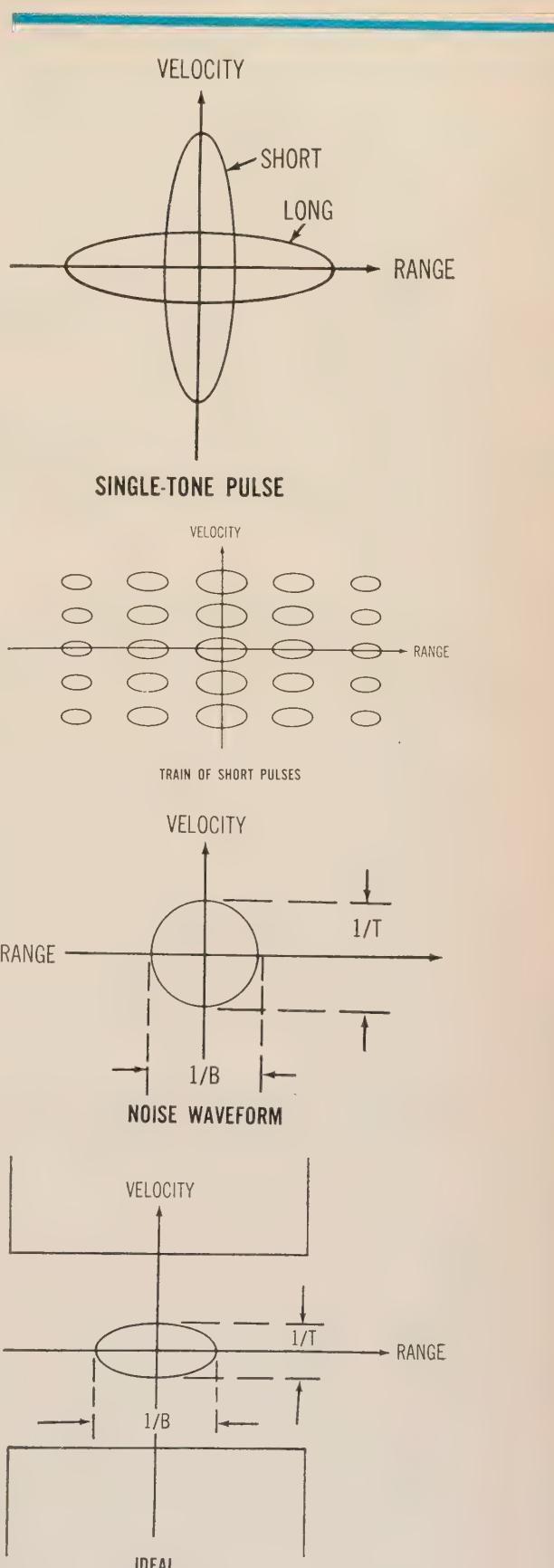
$$(5) \quad A(\tau, \phi) = \int H^*(f) H(f + \phi) e^{-2\pi f \tau} df.$$

Either *Equation 4* or *5*, provides a complete description of the ambiguity function for a coded signal. The contours of this function that parallel the range-time axis represent the time response of a matched filter to the signal for any given value of  $\phi$ . Contours parallel to the velocity-frequency axis represent the "spectrum" of the outputs from the matched filter bank at a given value of time.

Since it is the result of complete matched-filter processing of the signal return, this ambiguity function represents all the information that the radar signal contains regarding target range and velocity. It provides a measure of the ability of the radar to resolve targets in these dimensions in exactly the same way that the antenna pattern indicates its ability to resolve targets in azimuth and elevation.

For example, when a pencil-beam antenna explores a point target in space, the shape of the target revealed on

*more on next page*



**FIGURE 4:** Ambiguity diagrams.

an azimuth-vs-elevation plot is not the point target but the shape of the exploring beam. Two targets are resolved only if they are separated by more than one beam-width. Similarly, when we radiate a signal to explore the two-dimensional (range-velocity) target distribution along a given line of sight, two targets will be resolved only if their combined range-velocity separation exceeds the "beamwidth" of the signal ambiguity function.

As with the antenna pattern, we may improve the *accuracy* in locating a single target as much as we want to by means of sufficiently high S/N ratios. In other words, we simply measure the location of the peak of the ambiguity function by techniques similar to, say, monopulse antenna methods.

When targets are to be detected in the presence of noise, jamming, or background clutter, however, it is resolution or beamwidth that counts. Because such signals lack coherence, they tend to sum in power rather than in voltage. So the ambiguity function should be expressed as the power distribution  $[A(\tau, \phi)]^2$  in determining the resolution.

### Some intuitive reasoning needed

At present, choosing the "ideal" waveform requires some intuitive reasoning. Certain ground rules, though, can be deduced from *Equations 4 & 5*:

- Range resolution is largely determined by the frequency structure and Doppler resolution by the time structure of the signal.
- For a signal duration of  $T$  seconds, the best Doppler resolution is  $1/T$  cycles; for a bandwidth of  $W$  cycles, the best range resolution is  $1/W$  seconds (*Fig. 3*).
- For a given duration, the best Doppler resolution is obtained with a signal that is flat in time. For a given bandwidth, the sharpest range resolution requires a signal flat in frequency. This situation favors the use of various types of phase modulation. A nearly ideal waveform would be clipped white noise (*Fig. 3*).

Unfortunately, such a signal must contain a statistically large number of independent samples to come satisfactorily close to the ideal. Matched filter processing equipment for such signals tends to get out of hand.

• Normalized with respect to total signal energy, the power ambiguity function has a peak value of unity and unit total volume. Height and total volume of the ambiguity function for an ideal coded signal are therefore the same as for the simple pulse.

However, while the pulse function is a relatively simple main lobe of unit height,  $2T$  seconds' total length, and  $2W$  cycles' width, the "ideal" signal function is a sharp central spike of unit height,  $1/W$  seconds' length, and  $1/T$  cycles' width, surrounded by low skirts extending out of the limits of  $2T$  seconds and  $2W$  cycles. Therefore, as the time-bandwidth product of the coded signal increases from its value of unity for a simple pulse, more and more of the total volume is represented by the low, extended skirts of the ambiguity function and less and less by the central spike.

Under unfavorable conditions, we may lose "contrast" between a target and its surroundings, since nearby targets will contribute their skirt responses to hide the desired target. At worst, when the entire skirt area ( $2T, 2W$ ) surrounding a target is solidly filled by clutter in both range and velocity, the coded signal will give results no better than a simple pulse. (This does *not* increase the susceptibility to jamming—for a jammer to

fill the entire skirt area solidly it would need a large increase in energy.) Usually, the clutter occupies a small fraction of the skirt area, and performance will be better than that of the simple pulse by a factor that depends on the bandwidth increase of the coded signal.

Actually, there is a more "ideal" signal than clipped noise. As *Figure 3* also shows, when a signal is repetitive in time or frequency, its ambiguity function, too, becomes repetitive. The case shown is that of a train of short pulses with "side lobes" representing the well-known blind-speed and second-time-around responses. While normal blind speeds tend to fall in the velocity range of interest, proper use of repetition in the signal code may enable us to push the skirt responses outside this range. We then can increase the resolution without introducing *harmful* skirt response (*Fig. 3*).

*Figure 4* shows two examples of a type of signal coding that offers interesting possibilities. In both cases are signals generated by dispersing a narrow impulse with a flat spectrum that is sharply cut off at the edges of the desired band. The flat spectrum provides the best possible range resolution for a given bandwidth. Neither of the two signals is ideal in the sense of having a flat time waveform that would allow limiting without some loss of information.

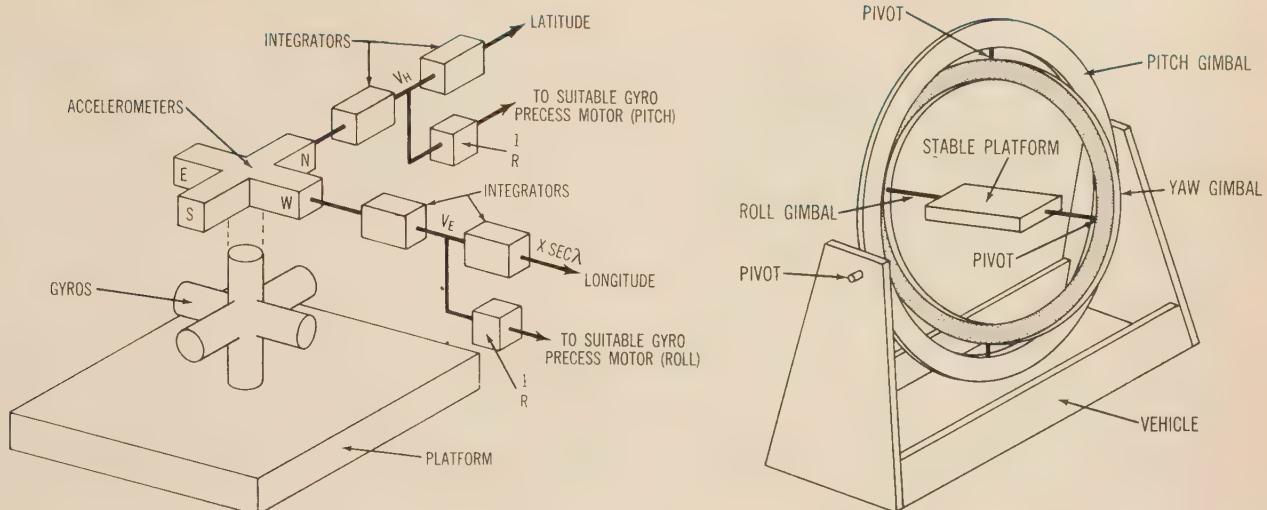
A *linearly dispersed impulse* is produced by passage through a filter with a square-law phase or linear time-delay-vs-frequency characteristic. Since the high frequencies are delayed more than the low ones, the result is an extended pulse with a duration roughly equal to the maximum delay difference of the filter and with a linear frequency modulation. An ingenious circuit for coding and decoding such a signal has been developed at GE's Electronics Lab.

### Chirp does not approach ideal

The ambiguity function for this signal (*Fig. 4*) shows that, while the technique used in Chirp—a matched-filter system developed by Bell Labs—offers some of the advantages of pulse coding, it does not approach the ideal in range-velocity resolution. Its ambiguity contour resembles that of the short pulse, except that its long dimension lies along a diagonal in the range-velocity plane. Targets whose range-velocity separations lie along this diagonal line will be poorly resolved. For single targets and high-S/N conditions the accuracy of range and velocity measurements may be improved by using Chirps of opposite sign on successive transmissions.

A *sinusoidally dispersed impulse* is produced by passage through a filter with a sinusoidal time delay characteristic. The result is like an extended pulse containing one cycle of sinusoidal FM, except that the time waveform corresponds to the spectrum of normal FM and the spectrum to the time waveform. The ambiguity function for this signal (*Fig. 4*) shows a combined range-velocity resolution that is not far from ideal. Under certain conditions, more than one cycle of "FM" could be used to get better resolution at the expense of "side lobe" responses falling outside the velocity range of interest.

Even a truly ideal coded signal is useless unless it can be processed to yield all the information it contains about target range and velocity. As suggested in *Figure 1*, a bank of matched filters could be used, with each filter tuned to a different velocity. It is not necessary in this scheme to completely duplicate the complex matched filter structure for each velocity.—End



**FIGURE 1:** In a typical inertial guidance system, the accelerometers (left), which sense the vehicle motion in the north-south and east-west directions, are horizontally positioned on a platform and aligned to some azimuth reference. Three gyros sense the yaw, pitch, and roll motions. The overall system includes a spherical trigonometric computer of some form for converting distance

traveled into the corresponding latitude and longitude changes for the vehicle's particular latitude. Right: The platform is suspended in a gimbal system to give at least three degrees of freedom. When the vehicle's attitude or heading changes, the gyro signals are used to keep the platform (and so the accelerometers) in the horizontal plane.

## Simplified dynamics for easier inertial design

**Inertial guidance dynamics don't have to be a major headache to the designer—you can set up a simplified situation that gives you a broad frame of reference for defining your system and its operational modes and yet preserves the qualitative definition of factors.**

by **Bernard Lee**, Advanced Servo Engineer, Electronics & Avionics Div., The Emerson-Electric Manufacturing Co.\*

**T**HE PRACTICAL design of inertial guidance equipment becomes quite complicated once you get into the spatial relationships and dynamics that it involves. However, you can get a useful understanding of inertial-guidance dynamics by analyzing a simplified situation in which vehicle motion is restricted to a plane containing a great circle of a spheroidal, non-rotating earth. In actual practice, of course, the continuous measurements of time, gravitation, acceleration, and angular velocity needed for inertial guidance must be made in a three-dimensional coordinate reference system.

An inertial system can guide itself from a starting

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**Table I:**
**Error Response in Vertical  $E_V$  to Prime Disturbance Inputs during Leveling-Alignment Mode**

$$E_V(S) = \frac{A(S^2 + BS + CS)V(S)}{D(S^2 + ES + F)(H\tau_0 S)} \pm \frac{G(H\tau_1 S)\theta_1(S)}{S^2 + ES + F}$$

$$\pm \frac{HSU_1(S)}{S^2 + ES + F} \pm \frac{HK_i U_A(S)}{S^2 + ES + F} \pm \frac{J(1 + \tau_2 S)U_0(S)}{S^2 + ES + F}$$

$$A = \tau_0(1 - K_1 K_2 K_a K_g R_E),$$

$$B = \frac{1 + K_i K_2 \tau_0 - K_g K_0 R_E (K_1 K_3 - K_4) - K_1 K_i K_a K_g R_E}{A},$$

$$C = \frac{K_i K_2 (1 - K_4 K_g K_0 R_E)}{A}, D = R_E, E = K_1 K_2,$$

$$F = K_i K_1 K_g K_a g, G = K_i K_2 = \frac{1}{\tau_1},$$

$$H = K_1 K_g, J = K_g (K_4 - K_1 K_3),$$

$$\tau_1 = \frac{1}{K_i K_2}, \tau_2 = \frac{K_4 - K_1 K_3}{K_i K_2 K_4}$$

**Table II:**
**Magnitude of Error in Vertical  $E_V$  during Leveling-Alignment Mode**

$$K_a = 1, K_i = 1, K_g = \frac{1}{R_E}, U_0 = 0, U_A = 0$$

**Case 1 — No Velocity Reference:**

$$K_3 = 0, K_4 = 0, U_I = 0, U_T = 0, E_V = \frac{K_2 V}{K_1 g}$$

**Case 2 — Velocity Reference (Once):**

$$K_3 = 1, K_4 = 0, U_I = 0, U_T = 0, E_V = \frac{K_2 V}{K_1 g}$$

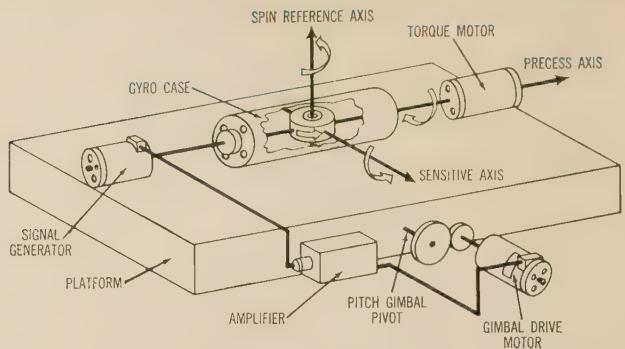
**Case 3 — Velocity Reference (Twice):**

$$K_3 = 1, K_4 = 1, U_I = 0, U_T = 0, E_V = \frac{K_2 (1 - K_0) V}{K_1 g}$$

**Case 4 — No Velocity Reference with Bias Error  $V_C$ :**

$$K_3 = 0, K_4 = 0, U_I = \pm V_C, U_T = \pm V_C$$

$$E_V = \frac{K_2 (V \pm V_C)}{K_1 g}$$



**FIGURE 2:** Mounted on the gyro output axis, a signal generator produces a signal proportional to the angular displacement of that axis (left). The precessing of the gyro through the vehicle's angular motion causes a displacement. The pickoff signal from the generator is amplified and applied to a motor to force a counter-rotation of the platform. In this way, the gyro is precessed to its

point to a fixed destination. It measures the distance traveled by registering the accelerations resulting from the forces exerted on the vehicle. Double integration of these accelerations gives the displacement. The forces on the vehicle are detected by accelerometers whose sensitive axes are related to a stabilized frame of reference, usually a gyro-stabilized platform (Figs. 1 & 2).

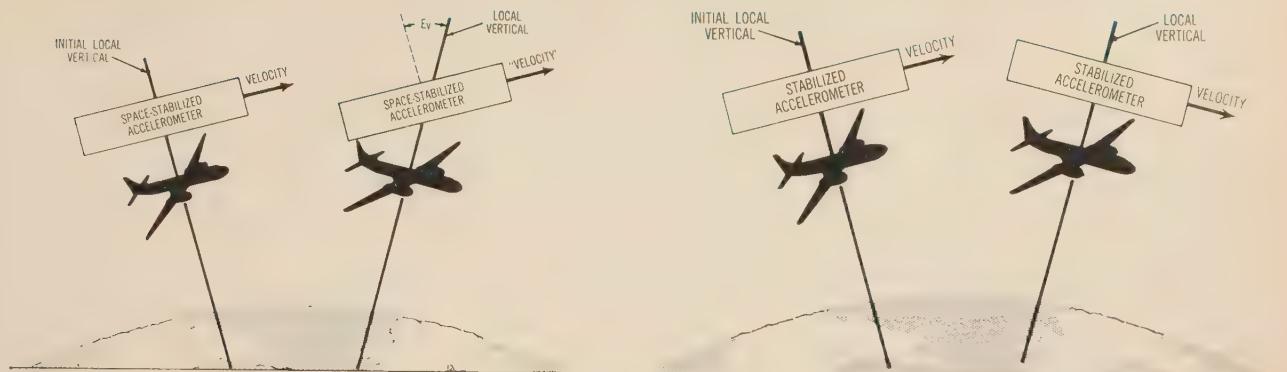
**Typical system has three gyros**

The gyro-stabilized platform insures that the measurement of linear acceleration components will be in a direction determined by the frame of reference, regardless of changes in vehicle attitude. There is no unique relative disposition of accelerometers and gyros on the platform. Each may be gimbaled separately to define different situations—the local vertical and inertial space, for instance.

A typical system carries three gyros to sense yaw, pitch, and roll motions. The platform itself is suspended within a gimbal system that gives it at least three degrees of freedom. The accelerometers may be rigidly affixed, or strapped down, to the carrying vehicle, in which case a more complex computer must be used to figure the proper space transformation. This computer is also used to figure distance-to-go and heading-to-fly to destination.

**No definitive qualities are lost**

If we assume vehicle motion is restricted to a single degree of freedom, we may describe the dynamics of inertial guidance in a simplified manner without losing any definitive qualities. In our hypothetical situation, variations in altitude are virtually imperceptible—they are so small compared with the earth's radius that the length of the local vertical nearly equals this radius. The



original condition, whereupon the pickoff signal goes to zero and the platform is properly oriented. Center: The movement of the vehicle around the earth, the earth's movement around the vehicle, or the combination of both movements displaces the horizontally aligned

accelerometer from the local vertical. Right: In the corrected case, the accelerometer is horizontally aligned at the beginning of flight and then continuously rotated so that it moves through the same angle relative to the earth as does the vehicle.

only significant vertical force acting on the vehicle is gravity.

Within the framework of the single-degree-of-freedom situation, it's quite easy to study the important leveling-loop dynamics. The leveling loop is involved in the initial alignment of the platform perpendicular to the local vertical, because of which the horizontal accelerometer senses only horizontal forces. Leveling is done with the vehicle either at rest or in motion. Since the former method actually is a special case of the latter, we'll discuss only the in-motion leveling loop.

### Linear velocity is basic input

In Figure 3, a closed-loop block diagram of the simplified in-motion leveling dynamics, the vehicle's linear velocity with respect to the earth is the basic system input. The orientation of the platform with respect to a datum plane perpendicular to the initial local vertical is measured in terms of angle  $\theta_p$  and may be taken as the system output. The platform alignment error with respect to a line perpendicular to the instantaneous local vertical is represented by the angle  $E_v$  (error in the vertical). Even though it can't be measured physically as an independent factor,  $E_v$  is clearly the most important parameter.

The relative angular velocity ( $\dot{\theta}_R$ ) between the vehicle and the center of a stationary earth equals the ratio of the vehicle's linear velocity to the earth's radius ( $R_E$ ). The integral of this angular rate yields  $\theta_R$ , the angle described by the local vertical as a result of the vehicle's motion over the earth. These relationships may be expressed as:

$$\theta_R = V/S(R_E),$$

where  $S$  is the complex-frequency variable of the Laplace transformation.

The error in the vertical therefore is:

$$E_v = \theta_R - \theta_p \pm \theta_I,$$

where  $\theta_I$  is the initial angular platform alignment error. When the system is perfectly leveled, the horizontal accelerometer senses only the horizontal component of linear acceleration ( $VS$ ). If the platform is out of alignment with the local vertical by an angle  $E_v$ , the accelerometer also senses a component of gravity:  $g\sin E_v$ , or approximately  $g(E_v)$  for small angles.

The input to the horizontal accelerometer then is:

$$P = VS + g(E_v).$$

### Accelerometer dynamics neglected

As Figure 3 shows, the dynamics of the accelerometer are neglected, and only the scale factor ( $K_a$ ) remains to represent its transfer function. So we may express the input of the integrator loop as:

$$Q = K_a P \pm U_a,$$

where  $K_a P$  is the output of the accelerometer and  $U_a$  the acceleration level uncertainty (noise, bias error, etc.).

For damping during the leveling mode, a loop is provided around the integrator with a scale factor of  $K_1$ . The output of the integrator is combined with the velocity level uncertainty ( $U_I$ ) and compared with the output of an independent velocity-measuring device (a Doppler radar or the vehicle's master inertial guidance system).

If the two signals are exactly equal, nothing is fed through  $K_1$  or  $K_2$ , the forward loop gain and the feedback factor, respectively. The platform is so oriented that the integrator reads out a velocity equal and opposite to that of the external velocity-measuring device plus or minus  $U_I$ . Complete cancellation means the platform is properly leveled and lies perpendicular to the local vertical. Obviously, leveling can only be as accurate as the velocity-reference system that's used.

The velocity-reference system may be represented by a single transfer function:

**more on next page**

Table III: Error Response in Vertical  $E_V$  during Navigation Mode

	$V$ Vehicle Velocity	$U_A$ Acceleration Uncertainty	$U_I$ Velocity Uncertainty	$\theta_I$ Displacement Uncertainty
Input Level →	$\theta_I = U_A = U_I = U_T = 0$	$V = \theta_I = U_I = U_T = 0$	$V = \theta_I = U_A = U_T = 0$	$V = U_A = U_I = U_T = 0$
↓ Type of Input				
Impulse $Ay(t)$ $y(t) = \lim_{x \rightarrow 0} \frac{u(t) - y(t-x)}{x}$	$\frac{A(g - R_E\beta^2)\cos\beta t}{R_E g}$	$\frac{A\beta\sin\beta t}{K_a g}$	$\frac{A\beta^2\cos\beta t}{K_a K_{ig}}$	$A[y(t) - \beta\sin\beta t]$
Step A	$\frac{A(g - R_E\beta^2)\sin\beta t}{R_E g \beta}$	$\frac{A(1 - \cos\beta t)}{K_a g}$	$\frac{A\beta\sin\beta t}{K_a K_{ig}}$	$A\cos\beta t$
Ramp At	$\frac{A(g - R_E\beta^2)(1 - \cos\beta t)}{R_E g \beta^2}$	$\frac{A(\beta t - \sin\beta t)}{K_a g \beta}$	$\frac{A(1 - \cos\beta t)}{K_a K_{ig}}$	$\frac{A\sin\beta t}{\beta}$
Sinusoidal $A \sin at$	$\frac{aA(g - R_E\beta^2)(\cos at - \cos\beta t)}{R_E g (\beta^2 - a^2)}$	$\frac{A\beta(a\sin\beta t + \beta\sin at)}{K_a g (\beta^2 - a^2)}$	$\frac{aA\beta^2(\cos at - \cos\beta t)}{K_a K_{ig}(\beta^2 - a^2)}$	$\frac{aA(\beta\sin\beta t - a\sin at)}{\beta^2 - a^2}$

$$RS/VS = K_D/1 + \tau_D S,$$

$U_D$  is the uncertainty factor of the velocity-reference system and  $K_D$  the particular scale factor of the integrator loop.

The amplified error signal through  $K_1$  is used to torque the platform to its correct position (Fig. 2). The dynamics of the gyro-stabilized platform for our purposes are represented as a simple integrator with a scale factor  $K_g$ . (Actually, these dynamics are far more complex, including as they do the mechanical and electrical transfer functions of the gyro, the torquer dynamics, the compensation network, and other types of electronics.)

A velocity reference signal that is added to the amplified error signal is used to torque the platform. Thus the platform is not only corrected for alignment errors but also driven to describe the same angular motion as the vehicle itself with respect to the earth's center. Adding the velocity-reference signal at this junction provides an anticipatory control but is not absolutely necessary for proper leveling. In our discussion, we'll refer to the presence and absence of the velocity-reference signal at the platform torquing level as *velocity-reference-twice* and *velocity-reference-once*, respectively.

The particular scale factor of the velocity-reference system and the stabilized platform loop is represented by  $K_4$ . The torquing level uncertainty ( $U_T$ ) covers calibration errors, noise, bias errors, etc.

In practice, a signal proportional to the earth's rate of rotation is added at the torquing level junction to make the platform and accelerometers rotate continuously at a rate equal to the relative angular velocity between vehicle and earth. (Where we assume a rotating earth, we also assume that discrepancies in computing the earth's rate for platform torquing purposes are taken care of by  $U_T$ ).

Table I gives the response of the error in the vertical

$E_V$  to such prime disturbance functions as  $V$ ,  $\theta_I$ ,  $U_I$ ,  $U_A$ ,  $U_D$ , and  $U_T$  in the leveling-alignment mode. Table II shows the magnitude of  $E_V$  for four typical cases. This magnitude is the same with velocity-reference-once as without any velocity reference. With velocity-reference-twice, an ideal external velocity-measuring device ( $K_D = 1$ ) would reduce  $E_V$  to zero. Without a velocity reference and with arbitrary bias  $V_o$ , at the velocity and torquing levels,  $E_V$  may be arbitrarily increased or decreased.

An inertial system's navigation loop comes into play when the system is used as an independent source for guidance. Figure 4 shows a closed-loop block diagram of the simplified navigation loop dynamics, using the same symbols as Figure 1.

#### Only one new parameter is added

The only new parameter is  $U_G$ , the position level uncertainty (noise, bias error, gyro drift, etc.). Also, the velocity-reference device is lacking (the vehicle, generally speaking, has separated from its carrier by this time) and there is an open feedback loop around the integrator to allow for Schüller tuning.

Schüller tuning imparts to the system the characteristics of a physical (distributed-mass) pendulum that will remain along the vertical as its pivotal point moves over the surface of the earth. As the vehicle passes over the earth's surface, the vertical associated with its instantaneous position rotates geocentrically with respect to a fixed reference system at an angular acceleration expressed as:

$$\alpha_V = V/R_E.$$

At the same time, the torque derived from the action of the accelerometer on the device's pendulousness rotates the pendulum relative to the fixed earth at an an-

gular acceleration expressed as:

$$\alpha_p = b \dot{V} / k^2,$$

where  $b$  is the distance between the pivotal point and the center of mass and  $k$  the radius of gyration.

To keep the pendulum aligned with the local vertical during acceleration,  $a_y$  must be equated with  $\alpha_p$ . (The inertia reaction produced as the pendulum remains vertical absorbs precisely the torque produced by the force of the acceleration on the pendulum.) We may express this requirement as:

$$k^2/b = R_E.$$

The period of the compound pendulum is known to be:

$$T = 2\pi\sqrt{k^2/gb}.$$

By substitution we get:

$$T = 2\pi\sqrt{R_E/g}.$$

Once aligned according to the vertical, the Schüler-tuned system continuously indicates the vertical, regardless of the vehicle's accelerations. On the other hand,

if the platform is originally set up with an alignment error, it will oscillate continuously with the amplitude of the original alignment error at the natural 84-minute period of the pendulum.

### Beta adjusted for correct tuning

*Table III* gives the responses of the error in the vertical ( $E_V$ ) to such disturbance inputs as  $V$ ,  $\theta_I$ ,  $U_I$ ,  $U_A$ , and  $U_G$  in the navigation mode. Note that the parameter  $\beta$  corresponds to the system's undamped natural frequency. Therefore, when it is adjusted to equal  $\sqrt{g/R_E}$ , the system is Schüler-tuned with no error in the vertical due to velocity or acceleration inputs.

It's apparent that an initial platform alignment error with respect to the local vertical (represented in *Table III* by a step input in  $\theta_I$ ) produces a sinusoidal response of the "error in the vertical" at the  $\beta$  frequency whose magnitude equals that of the initial alignment error.—End

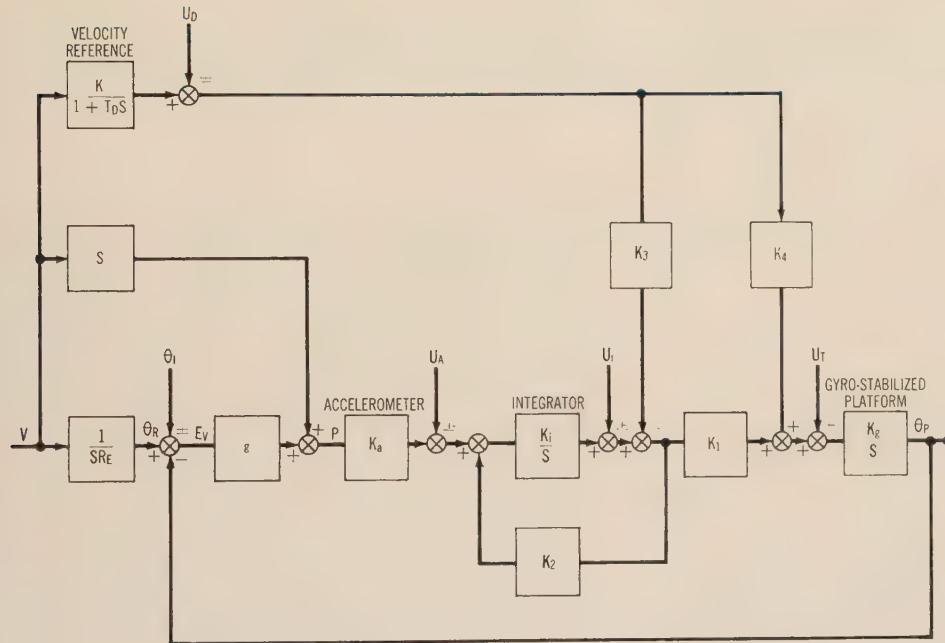


FIGURE 3: Simplified dynamics of leveling loop.

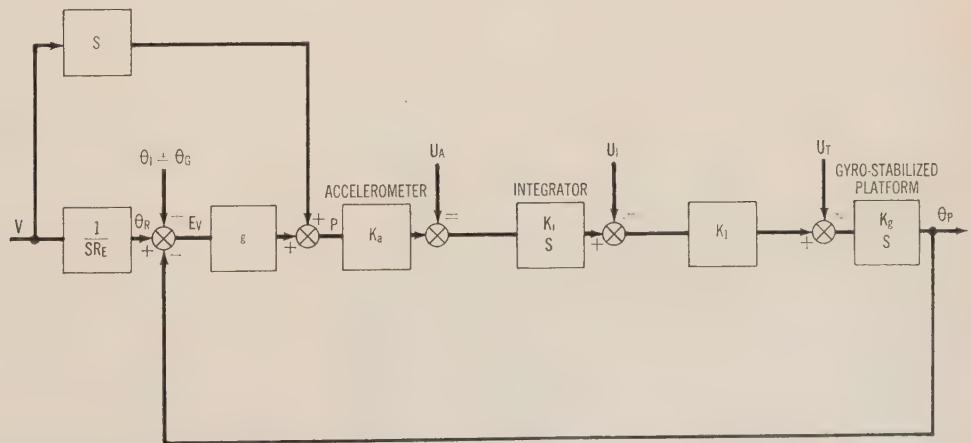


FIGURE 4: Simplified dynamics of navigation loop.

## Cost limits automation of checkout equipment

- Most of today's checkout tests are "predetermined"
- Military unwilling to pay for advanced designs
- Computer-directed test sets seen for the future

by James Holahan, Electronics Editor

**FIGURE 1:** Central programer-comparator developed by Autonetics for checking out the NAA A3J attack bomber. The cart holds tape programer, air conditioning, analog-digital converter, decoder, counter, timer, and comparator. Most of its electronics is mounted in accessible drawers.

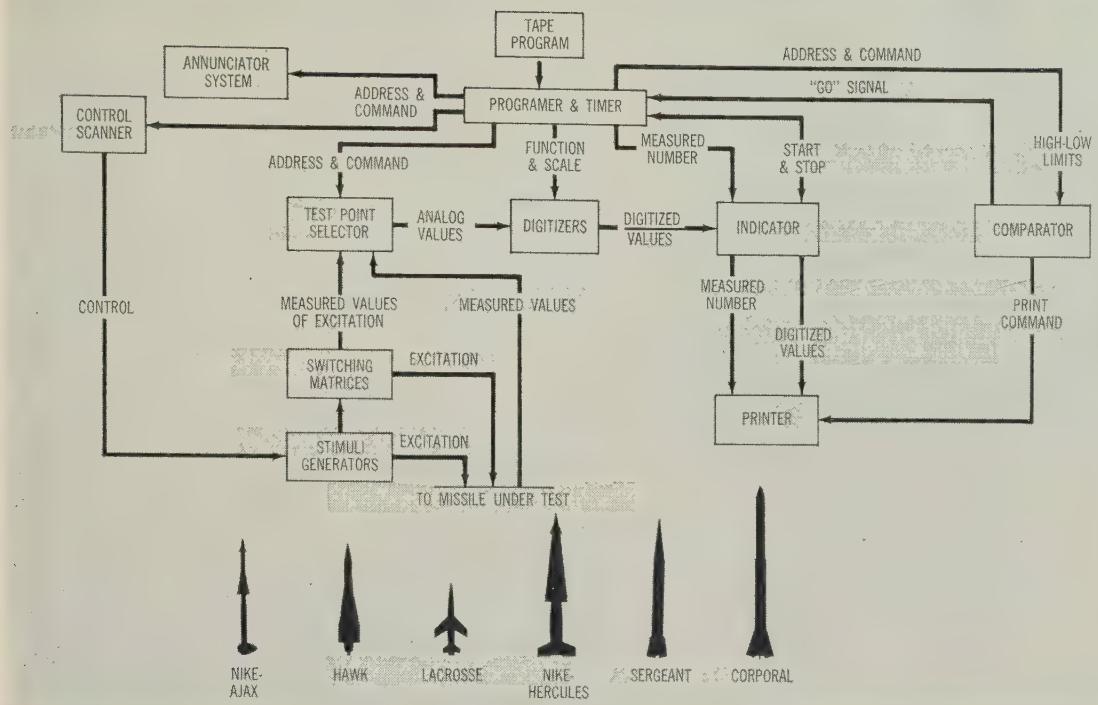


**E**LCTRONICS' MAIN ROLE in ground support lies in the automatic checkout complete weapon systems and subsystems. What is "automatic checkout?" You'd think there couldn't be much misunderstanding on this point. But actually the term has been stretched and twisted to cover a variety of more or less conventional test gear with some automatic or semi-automatic features. So we'd better start with a definition.

As Epsco, which makes the Guardian family of checkout sets system puts it, "an automatic checkout system is an automatically programmed test set capable of sequentially generating and transmitting programmed commands and excitations relating to the component performance of the device being tested . . . [of] receiving from that device measured parameters that it can compare with stored standards of condition and performance, and [of indicating on the basis of these] comparisons . . . the operational status of the device, issuing malfunction alarms and corrective instructions as necessary."

One of the surprising facts about automatic checkout is that there is no operational automatic checkout equipment for a complete vehicle in use in current military maintenance. (Several systems of this kind exist as prototype hardware.)

It's not, of course, that we don't need automatic checkout equipment for complete vehicles—the maintenance situation is steadily getting worse, while the weapons are growing more complex. The trouble probably is that the weapon system developers have been forced to concentrate on making the primary weapon work and then on improving its performance. Checkout gear in most cases has been an afterthought. As a result, most weapon system prime contractors and the military, are still not sure just what kind of checkout equipment they want.



**FIGURE 2:** Nortronics' Datico "universal automatic test system" for six Army missiles is representative of the current operational hardware for automatic checkout.

The prime equipment on most new weapon systems has led the test equipment by at least a year. This has compounded the test set design problem since it generally prevents design changes that would make the weapon more "testable"—for example, by bringing out test points or locating critical units more accessibly. Ideally, of course, the weapon designer should keep in mind from the outset that his system is to be tested automatically, and on top of that the test set designers should be made part of the design team right from the beginning.

### Many systems remained stillborn

A number of checkout systems have been designed for particular weapons. Many of these systems have never got far beyond the development stage—for such reasons as excessive complexity, poor performance in the operational environment, and high cost. Cost has been a particularly bad problem. In interviews with SPACE/AERONAUTICS, engineers from automatic checkout design groups throughout the country stressed the need for economy. They pointed out that, at the present state of the art, we could design test equipment that would be much more sophisticated than our current hardware, but that the military is not willing to pay the high price of sophistication. (A major exception is Lockheed's Acre system—see *R&D Handbook 1959-1960*, "Polaris Acre: Integrated Checkout from Factory to Sub," page L-5).

Most checkout sets now in development use what might be called "predetermined" testing. Commands and test sequences and limits are prepared on punched paper tape by the test set designers, who work closely with the designers of the weapon to be tested. Only

a limited amount of logic may be programmed into these machines. For example, the machine may be commanded to follow a certain preprogrammed subroutine in the event of a "No Go" indication.

However, all the actions of the machine are preset. There is no new thinking once the start button has been pushed. Both the sequence of the test and the limits are fixed—the only variables are the measured quantities.

The "predetermined" machine can do a certain amount of troubleshooting by inference. Several sample problems, for example, can be fed into it and, by judging their results, it might be able to localize the malfunction.

Proposals for more sophisticated automatic checkout sets call for a general-purpose computer to control and program the automatic test. These machines could make many "post-determinations"—the initial sequence would be predetermined, but the results of each test would determine the tests that follow.

Also, the computer-directed machine could do much more extensive troubleshooting without the help of a technician familiar with the weapon under test and its subsystems. With a computer in the loop, designers claim, the behavior of systems and subsystems could be analyzed, and mean time between failures could be predicted accurately.

Most checkout equipment designers believe that some sort of special-purpose, computer-directed test set is certain to appear eventually. They also agree that the

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**FIGURE 3:** Automatic equipment for factory checks of advanced Terriers and Tartars was developed by Convair-Pomona. Programmed through punched cards, it stores the test results in a magnetic-core memory. The same type of equipment can be applied in the depot maintenance of weapons and electronic systems.

military now is not willing to foot the bill for devices of this type. Many are of the opinion that it will take the armed services a while to get used to the first generation of automatic checkout devices—and then there'll probably be a call for improvements. At that time, some form of a computer would be the next logical addition, designers say.

The economic situation in their field may be the worst headache of test equipment designers, but it isn't their only one. They also have their engineering problems. Some of the most pressing of these are:

- Our inability to design practical automatic equipment for *waveform analysis*—This problem may be solved by increases in checking speed, which would enable us to trace a waveform by making a series of quick point checks. The necessary switching speeds would exceed those of present equipment.

### Transient analysis as a solution

Transient analysis also has been proposed as a solution—certain step functions could be inserted into the circuit, and input signals could be compared with the outputs to determine phase shift and gain.

- The inability of automatic test equipment to detect *intermittent trouble*—Intermittents are the hardest troubles to spot for the automatic machine just as much as for the human technician. This problem, too, could be solved by higher switching speed at which, repetitive high speed tests might be made. Another approach being followed by researchers relies on the detection of the noise usually associated with many intermittencies.

- Difficulty in programing exact *RF power levels* for stimuli—The RF inputs needed in some sets might extend from fairly low frequencies to beyond 30 kmc.

- Development of *input-output devices* that will work without trouble in the rough military field environments.

Checkout equipment designers also get into trouble when the system makers do not provide enough accessible test points, particularly in the case of circuits encapsulated for environmental protection. They complain, furthermore, that technical manuals describing equipment contain many errors and that we lack agreed test equipment standards.

To get an idea of the state of the art in automatic checkout equipment, let's look at two units that may soon go into operational use: Nortronics' Datico "universal automatic test system" and Autonetics' GS-1A "automatic checkout and control equipment for weapons systems." (Scate, a third system using present-state-of-the-art hardware, is described in the Design Progress on page 201).

### Army asked for expanded Datico

In 1958, after about 3000 hours of test experience with an early model, Nortronics built a Datico system to check out the Nike-Hercules. The Army then requested that this machine be expanded to check out the Corporal, Hawk, Lacrosse, Nike-Ajax and Sergeant. The six-missile system is in hardware form and ready for operational testing. A similar system is being produced for the first production Polaris missiles. (Acre and the Lockheed-Packard Bell Acre-Octopus are scheduled for later Polaris.)

Datico is controlled by a perforated tape program. Measured values are converted to digital form, so that computer logic can be used to determine go and no-go conditions according to established tolerances.

Nortronics points out that, being able to check one entire complex missile system, Datico also has the inherent capability to test a large part of any other missile system. This capability underlay the expansion from one missile to six and makes future expansions possible, too. However, the company warns that it is a ticklish design problem to provide maximum flexibility and expandability in an equipment that will be economical to produce.

The universal Datico test set has four functional sections (Fig. 2):

- The *control center* contains the tape reading programer and time delay circuits indicators the test point selector (connecting the test points to the digitizers), the printer, the comparator, and the control scanner (for connecting up the service units).

- The *evaluation equipment* consists of various test sets (voltmeters, milliammeters, frequency meters, etc.) that are automatically connected to the test points by switching matrices. Measurements are made in analog form and converted to digital for display and comparison.

- The *service equipment* provides the necessary stimuli from (signal generators, power supplies, load banks, etc.) for the equipment under test.

- The *supplemental equipment* includes the test tapes, test procedure manuals, and adapters and cables for the missile to be tested.

The universal Datico is completely modularized to allow for future expansion. Electron tubes are used as the active circuit elements.

Autonetics' GSIA checkout equipment is fully transistorized and is built around a central programmer-comparator that performs three functions (Fig. 4):

- control of stimulus commands to operate the weapon system under test,

- measurement of selected system responses,
- evaluation of responses against preset limits.

*Figure 1* shows a central unit built for testing the North American A3J bomber. It contains instruments for measuring voltage, voltage ratio, resistance or impedance, frequency, and time.

For each weapon system to be tested, its own service units and adapters are used to tie it into the GS-1A programmer-comparator. Autonetics believes that the weapon system designer can do the best analysis of his system's test needs and therefore should provide the stimuli generators and the adapters to tie in with the central test set.

The GS-1A can control and checkout the following functional systems: pressure control, temperature control, fuel, engine, auxiliary power, hydraulic, electric, armament, flight control, guidance, and armament control.

A logic network in the GS-1A determines the operations to be performed as the result of each measurement evaluation. Depending on the result of the evaluation, the test sequence is continued, stopped, or shunted off to a subroutine to track down the cause of a no-go.

Wright Air Development Center apparently agrees with the approach that led Autonetics to the GS-1A—it has modeled USAF's new automatic checkout equipment spec (Mil-T-26664) after the GS-1A. The spec was distributed to the industry for comment in June, and WADC is now reviewing the comments.

Another state-of-the-art unit from one of the companies most experienced in automatic test set design is an automatic production line tester designed by Convair-Pomona and used on the advanced versions of Terrier and the Tartar missiles (*Fig. 3*). This type of equipment, says Convair, is directly applicable to field and depot maintenance testing.

Convair's test set is programmed by Remington-Rand punched cards. Tests are run at high speed, and the results are stored in a magnetic-core memory from which they are read out at a slower rate for comparison with the test limits. The storage feature minimizes the wear on the missile—the missile's systems are operated only during the high speed checks and not during readout and evaluation.

### Convair stresses design economy

Convair is opposed to the USAF-Autonetics checkout concept. It believes the central programmer-comparator makes for excessively large and costly equipment and deprecates inflexible central cores. You should be able to take the core apart and put it together again to do a particular job, Convair says.

The company generally stresses economy in its designs. It points out that the Raco automatic checkout system for the F-106 was never produced simply because it cost too much (about \$0.5 million per copy). At the same time, it emphasizes that automatic test equipment can lead to overall savings despite its high initial cost. Convair figures that it uses 75 per cent less test gear on Terrier now that it has gone to automation. It didn't save anything on the equipment, but the cost per test has dropped 97.5 per cent, Convair claims.

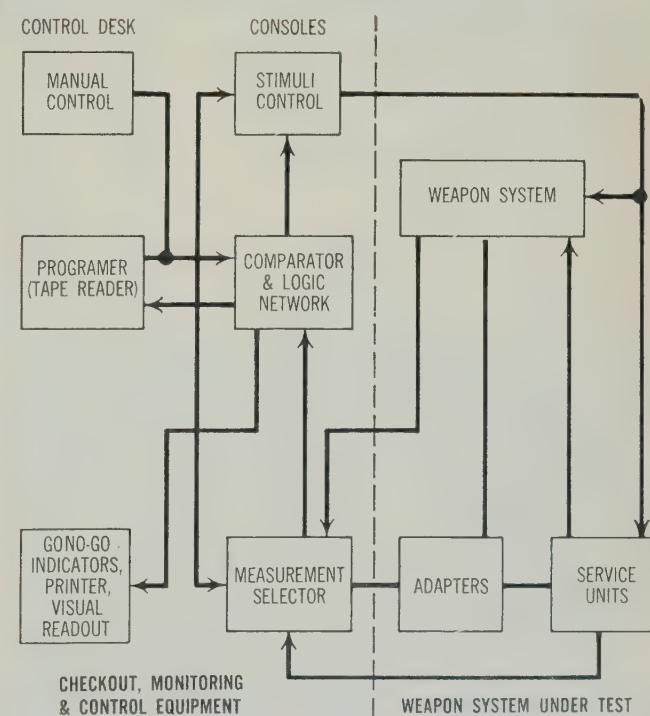
Generally speaking, the trends in automatic checkout equipment design point toward: solid state construction, special computer control and programming,

higher speeds, and larger memories. Future designs might very well resemble Curtiss-Wright's automatic Demon checker, which uses a random-access memory, or Nortronics' Norscan, which is mainly still in the conceptual stage and which would use computer control and a magnetic-drum memory. Another style setter might be Acre, which uses a computer and a memory drum.

One of the questions that still hasn't been answered to the military's satisfaction is, Who fixes the automatic checkout equipment when it breaks down? Won't this be just those skilled technicians of whom we don't have enough—which is one of the reasons why we need automatic checkout so badly in the first place?

Designers emphasize that they have built "trustworthiness" into their equipment by means of self-check features using sample programs and the like. However, absolute reliability, or "trustworthiness" seems to be beyond the grasp of humans just as much as perpetual motion, so it's reasonable to assume that breakdowns may occur that won't show up in self checking.

The ultimate goal of checkout equipment designers is to achieve a failure rate much lower than that of the equipment under test and to make maintenance easy. Since we've had little field experience with operational checkout units, much still has to be learned about how they will hold up. Not surprisingly, designers are all for setting equipment into the field fast, so that we can start spotting weak points.—End



**FIGURE 4:** Functional diagram of Autonetics' GS-1A "automatic checkout and control equipment for weapon systems."

# THE NAVY'S POLARIS:

## DONNER *helps it think...*

One day soon the U. S. Navy will file a report more fantastic than any sea serpent tale we've ever heard. This will be the launching of the Navy's spectacular Polaris missile from a submerged nuclear submarine. Advanced testing is underway; the Polaris will be ready for the fleet in 1960.

Smaller and lighter than other intermediate range ballistic missiles, this formidable Lockheed developed weapon features much that is new in advanced electronics. It even "thinks" for itself.

One such "think" device aboard the Polaris is a system developed by Donner Scientific Company using as a base a standard Model 4310 Accelerometer. The system monitors flight performance like a policeman directing traffic. If, for example, in the initial portion of the flight, the missile does not achieve sufficient velocity by a pre-determined time, the Donner system aborts the flight. The missile gets the go-ahead only as programmed.

Donner's role in the Polaris project represents another basic contribution from an engineering team which specializes in accurate systems, interlocking time, acceleration, velocity and other inputs designed to meet customers' requirements.

*Donner welcomes your inquiries concerning the company's capabilities in this and related fields.*

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16

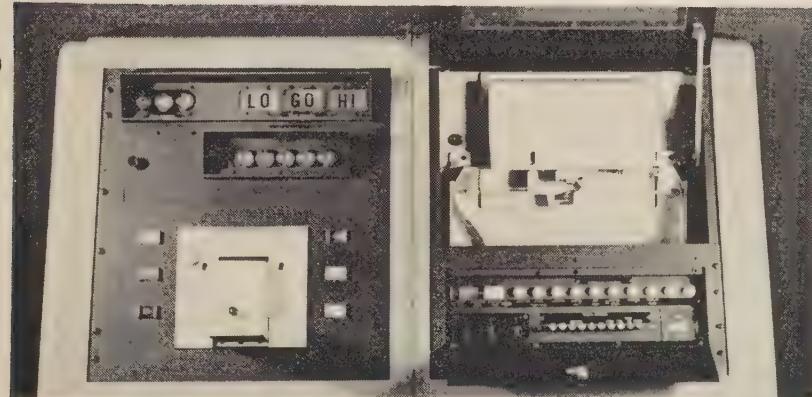
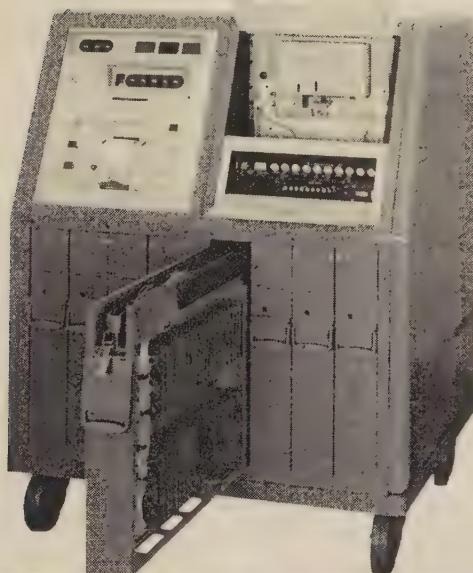


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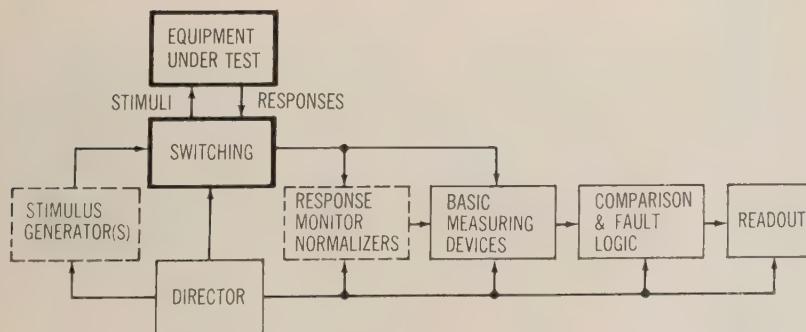
200

SPACE/AERONAUTICS

nuclear	systems & subsystems	company capabilities
checkout	SCATE	go-no-go testing



**SCATE** (Stromberg-Carlson Automatic Test Equipment) is built around modular programmer-controller (top) that handles generalized test functions. Transistorized, printed card circuits mount in removable racks in pull-out drawers. Control portion of typical system (center) contains punched-tape mechanism, visual and printed readout, manual controls. System can take program changes in midstream. Primary accuracy and timing is provided by primary standards and a master clock. Below: Scate design concept.



# design digest

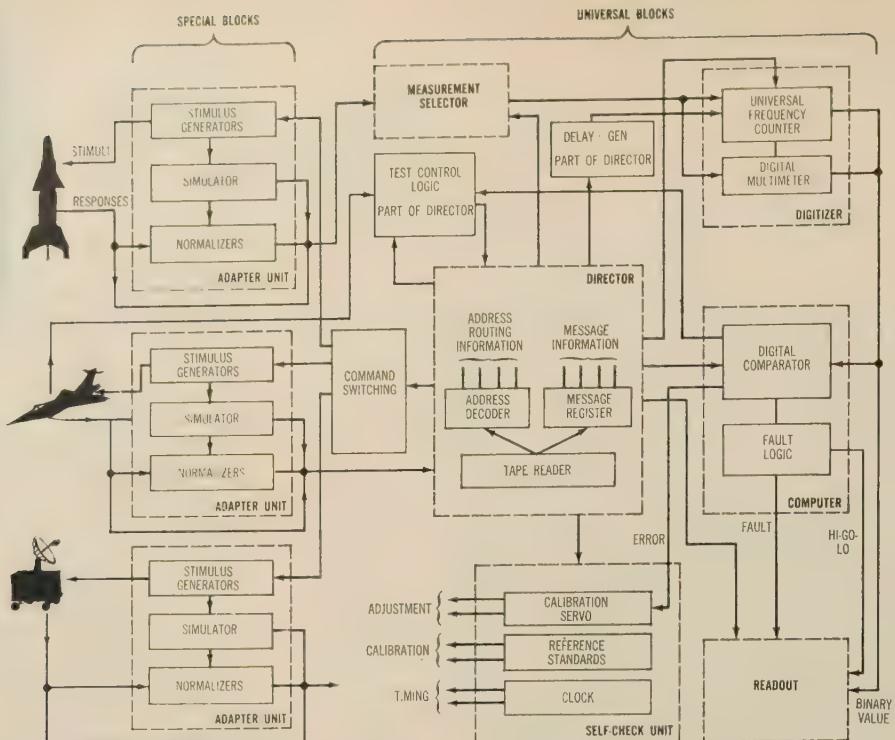
by **Bernard Kovit**

Associate Electronics Editor

## Scate: flexible universal checkout

DECIDING that no test system can be wholly universal and automatic, Stromberg-Carlson Div., General Dynamics' Corp., 100 Carlson Rd., Rochester 3, N. Y., designed its Scate as a modular digital system using flexible, self-checking adapter units. Universal portion includes director (tape and decoder), computer (comparator and fault logic), digitizers, self-check unit, and readout. Specialized portion—stimulus generators and response normalizers—translates specific test requirements of the system under test. In digital comparison, upper and lower limits or an exact value are programmed in. In comparing with limits, output is go-no-go (HI-GO-LO) signal. In comparing with a desired value, positive nor negative difference is taken. With system's six-digit capacity, quantities can be compared one part in  $10^5$  in less than a millisecond. Write in No. 76 on Reader Service Card for more data.

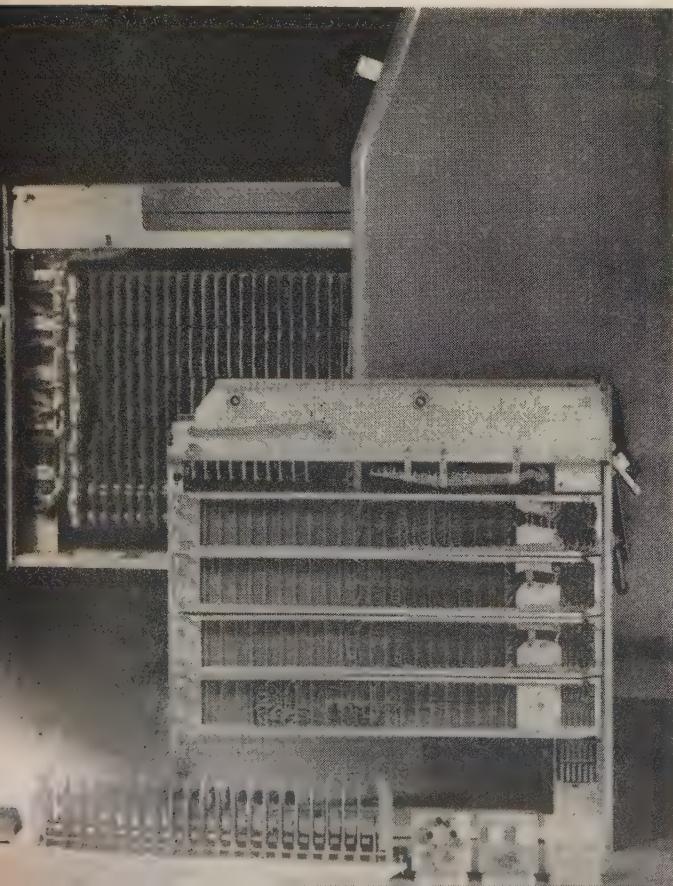
design  
digest



**FLEXIBILITY** of generalized Scate system is shown by three typical applications (above). Adapter units (special stimulus generators and output converters) translate specific test requirements of weapon system to the universal portion. With circuit mods in the adapters only,

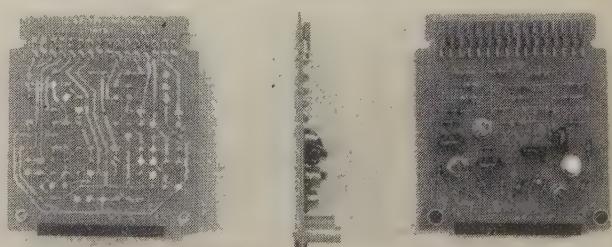
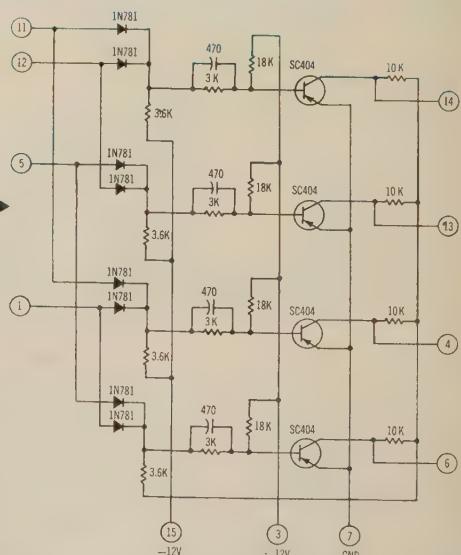
Scate can be applied to various types of equipment, says Stromberg-Carlson, which has developed several multi-purpose RF and video generators, for instance. Internal simulators in adapter units generate self-test signals as backups for parity checks and output monitors.

**CLEAN**, modular construction is very apparent in Scate. Drawers can be extended without interrupting operation for simpler servicing. Advanced version will have fault-isolation display on each drawer relating to internal card-modules.

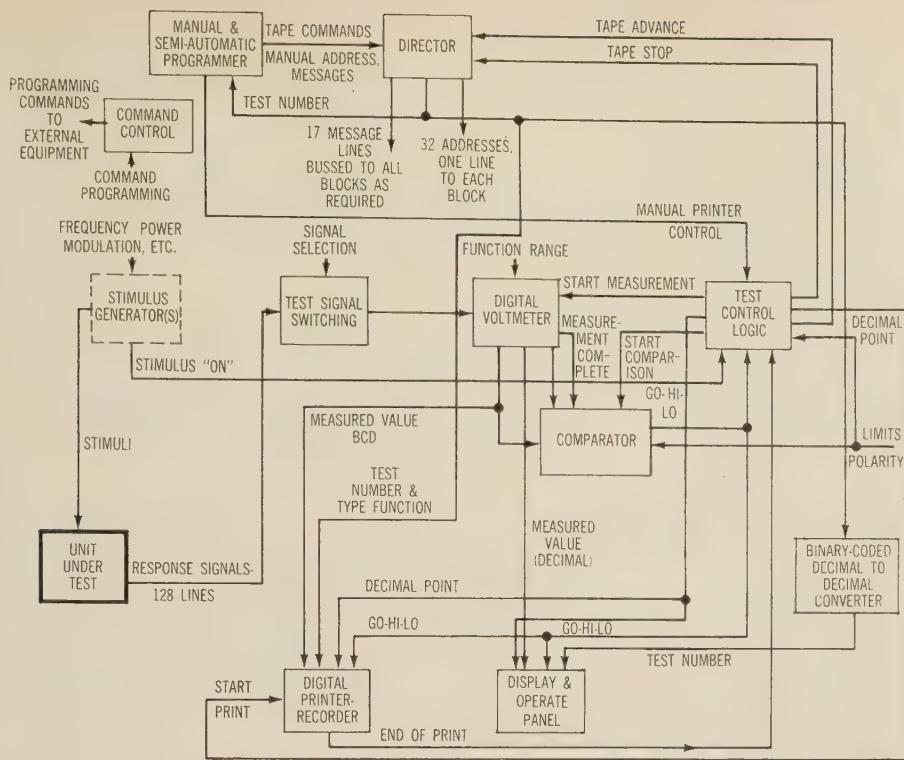


#### TYPICAL MODULE ▶

—Two-bit decoder is used to decode two bits of binary data into decimal information. In the application shown here, two message bits are used to program four measurement ranges for Scate's digital multimeter.



**PRINTED CIRCUIT CARD** (top, bottom, and profile views) contains entire two-bit decoder module. For maintenance, the 3 x 3½-in. cards are expendable.



**SCATE** accepts digital commands from programmed tape, decodes them, and routes them to basic tester block. Since Scate works on electric signals, transducers are included in tests of non-electric items. "Normalizer" cir-

cuits convert response signals to dc level, ac signal, or event per unit time. Signals are measured and digitized by digital voltmeter (counter) and compared with preprogrammed limits.

## Basic Scate Specs

**Test Voltage & Resistance**—Voltage: 0-500 V dc with  $\pm 0.05$  per cent accuracy; 0-500 V peak ac with  $\pm 0.1$  per cent accuracy. Resistance: 0-1 megohm with 0.1 per cent accuracy; 0-10 megohms with 0.5 per cent accuracy.

**Test Rate**—10 tests per second (higher rates can be set up if required).

**Test Capacity**—400 test signal leads from equipment under test.

**Input Resistance**—10 megohms for dc; 0.5 megohm for ac.

**Operation**—Can perform 999 primary and 999 subroutine tests automatically or semi-automatically from any single preprogrammed tape. No limit on number of tests programmed manually.

**Automatic Programming**—By reading binary-coded test information from 8-channel punched tape.

**Semi-Automatic Programming**—Can be operated in semi-automatic programming mode allowing selection of any test sequence on program tape and performance of that sequence only.

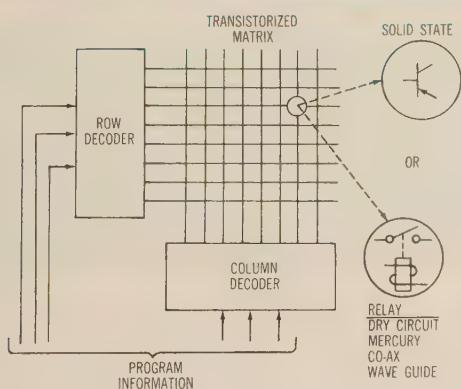
**Manual Programming**—Can be programmed manually to select test points not on the test tape.

**External Programming**—Accepts externally applied control signals.

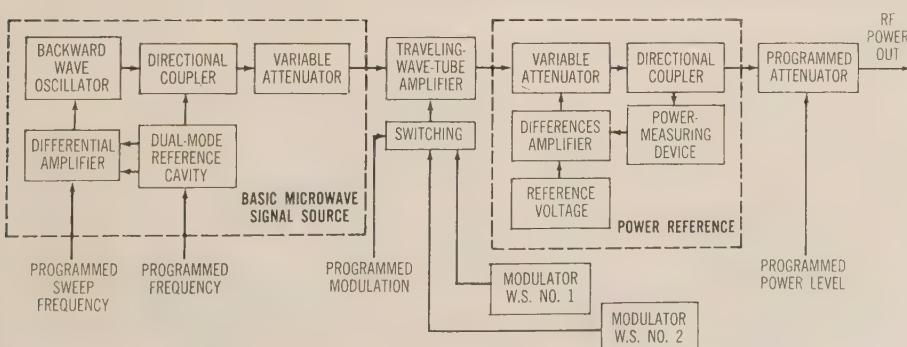
**Command Control**—225 command control points for programming of external circuitry can be set up in 15 groups of 15 lines each.

**Readout**—Test results displayed visually and printed; may also be recorded on punched or magnetic tape, according to S-C.

**Printing Rate**—Up to 20 lines per sec.



**MULTI-CIRCUIT** switching is done by means of a hybrid matrix switch made up of a transistorized matrix with a solid-state switch tied to each crosspoint. Binary information can be routed directly by the switches. However, they may be used also to operate various types of relays for handling high power and RF signals, etc.



**PROGRAMMABLE** microwave generator. Because of varying missile needs, it's hard to build one microwave generator usable for several missiles. When two

different missile systems use the same range of MW signals, a common carrier oscillator may be used, though separate modulators are still needed.

# Moments of proof

... and there are hundreds in an air-launched missile.

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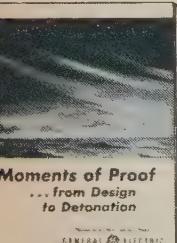
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# Patchboard programs

## checkout of Jupiter guidance

- Based on analog computer patching
- Simpler and smaller program storage
- More flexibility, less mechanical wear

by Emanuel Schnall, Project Engineer,  
A. B. Du Mont Laboratories, Inc.\*

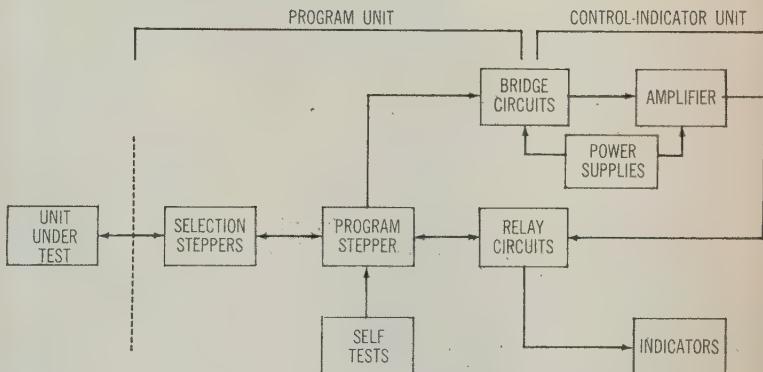


FIGURE 1: Functional block diagram of Du Mont automatic tester.

A NOVEL approach to automatic checkout is embodied in a compact go-no-go tester with patchboard programming developed by Du Mont. The automatic tester (*Fig. 2*) is designed for third echelon checkout of two stable platforms and four distributor units of the Army's Jupiter IRBM.

Test connections, limits, and sequence are set up by interconnecting contacts of a plugboard (*Fig. 3*) that mates with the contact springs of the patchboard (*Fig. 4*). This type of program storage reduces complexity and size and increases flexibility. It also avoids the mechanical wear inherent in punched-paper-tape systems.

The tester performs continuity, insulation, resistance, diode and multiple-relay checks in five-minute sequences

of 500 steps each. It occupies only 28 in. of rack height. (An equivalent tape-programmed design would need about 40 in. of rack height).

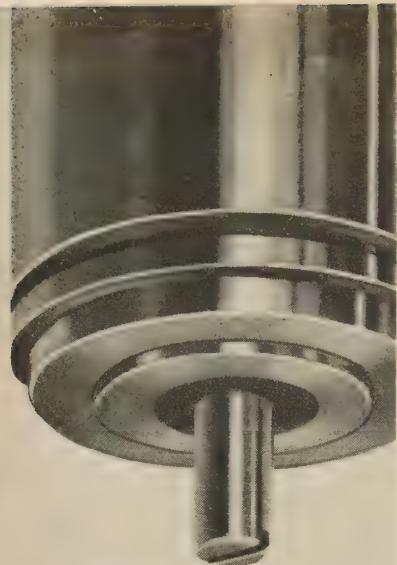
The Du Mont patchboard programming method is a logical extension of analog computer patching techniques and offers great flexibility when it is used with voltage-handling equipment. Since all the plugboard connections are accessible to the tester at the same time, the allocation of functions to each row of connections can be changed easily to meet special requirements—without any change in the unit's size or speed. For example, a section of 1000 contact points used for 500 continuity tests can be modified to provide 25 four-point tests for relay combinations and still leave 450 continuity checks.

The *Table* shows how 1100 contact points may be allocated to various types of tests to meet three test requirements. The number of tests can be varied from 350 to 725 without changes in patchboard size.

more on next page

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\*A. B. Du Mont Laboratories, Inc., 6 Main Ave., Passaic, N.J. Since writing this article, Mr. Schnall has joined Laboratory for Electronics, of Boston, Mass.



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## PATCHBOARD . . .

### Examples of Patchboard Capacity Allocation

Test Type	Points per Test	Example A		Example B		Example C	
		No. of Tests	No. of Points	No. of Tests	No. of Points	No. of Tests	No. of Points
Insulation	1	375	375	175	175	50	50
Continuity	2	275	550	175	350	—	—
Continuity, 2 relays	4	—	—	25	100	25	100
Non-Continuity, 2 relays	4	—	—	25	100	25	100
Diode	2	50	100	25	50	—	—
Resistance	3	25	75	75	225	150	450
Resistance, 1 relay	4	—	—	25	100	100	400
Total No. of Tests		725		525		350	
Total No. of Point.			1100		1100		1100

The number of patchboard contacts available for test allocation comes to about 67 per cent of the patchboard contact total. Input connections may use 400-600 contacts, or about 30 per cent of the total. The remaining three per cent are used for various interlock, cut-out, and auxiliary functions.

When there aren't enough con-

tacts on the patchboard to accommodate the units to be checked, a second plugboard can be wired up, and this unit can then be checked in two run-throughs. This procedure doubles the number of available tests and makes allocation easier. Yet the size of the basic tester remains unchanged, and the plug-

more on page 208

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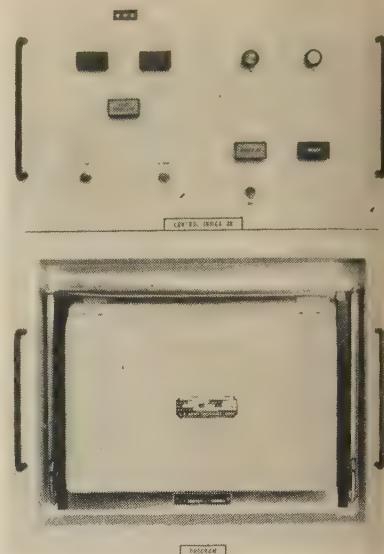
Inquiries from creative electronic systems engineering personnel at all levels are cordially invited  
Write in No. 140 on Reader Service Card at start of Product Preview Section

board storage space is increased only moderately.

Because all plugboard contacts are available at the same time, the scanning sequence can be optimized without time-sequenced programming inputs. Stepping switches therefore can be used on a single-increment basis—exactly one step per test. The sequence of the allocated tests is fixed, and stepper hunting is eliminated, mechanical wear and switching time are re-

duced, and contact life is markedly improved.

The stepping switch circuit selectors and the patchboard receptacle assembly are contained in the program unit. Figure 3 shows how a plugboard is inserted into the guides, after which the outer handle is closed to lock the plugboard into position. About a dozen quick-disconnects in the bottom of the program unit provide input connections for the missile unit



**FIGURE 2:** Control-indicator unit (top) has operator's switches and lights to show the testing situation. The program unit (bottom) holds the patchboard and the mating plugboard.

under test. The jumper wiring in the plugboard completes the circuits between the input contacts and those for the allocated test points.

Functionally the tester is made up of eight major blocks (Fig. 1). The selection steppers and the bridge circuits are connected and check the unit under test via plugboard connections in accordance with a scanning sequence wired onto the program stepper.

The amplifier determines whether the bridge error voltage is of the correct polarity for "Go". If it is, the relay circuits are signaled to advance the steppers to the next test. This process is repeated automatically until a "Go" signal is found missing or testing is completed. If a "Go" signal is missing, the indicator lights will show "Component Fault," and the test sequence will stop.

When the "Fault" light appears, the operator reads the test step number and decides whether he should search out the trouble there and then or record the step number for later investigations. To continue the test sequence he presses the "Test Resume" button. The test sequence then proceeds again—at the rate of about two tests per second—until another "No Go" condition is spotted or until the sequence is completed. The sequence will also stop if there's

A large, stylized illustration of a rocket launching from a launch pad, with a bright plume of smoke and fire at its base. The background is a cloudy sky. Overlaid on the right side of the image is the text:

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Variations of this lightweight, small size, low power consumption unit are available in a wide range of tape speeds and multiplicity of tracks. For more information on advanced recording techniques to meet your recording needs, write Marketing Branch, Lockheed Electronics and Avionics Division, 6201 East Randolph Street, Los Angeles 22, California.

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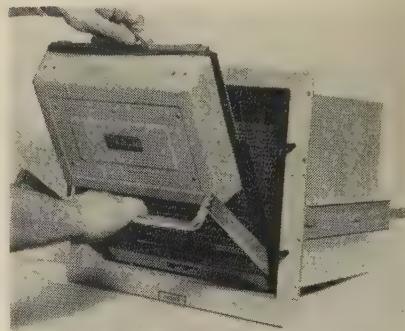
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**FIGURE 3:** Front and rear of plugboard. Test program is inserted by interconnecting the board's contacts.



**FIGURE 4:** The program is stored by insertion of the plugboard into the program unit, where its contacts mate with those of the patchboard.

a self-test failure, indicated by the "Tester Fault" light.

A variety of fail-safe and interlock features is built into the tester to insure reliable and trouble-free operation. These features protect against potential equipment failures and operator control errors. Several self-tests are also included as part of the test sequence.

The "Start" button is interlocked so that it can't work unless both the "Test Complete" and "Ready" lights are on. The "Ready" light is in turn interlocked so that it comes on only after 115-V ac warmup has been completed, 28-V dc power has been turned on, and a plugboard of the right kind has been locked into the program unit.

The "Component Fault", "Tester Fault", and "Test Complete" lights are wired so that only one of them can come on at any time. The "Component Fault" light is so connected at the start of each test that, if a "Go" signal does not appear within a prescribed interval, only the closing of a normally closed timer contact is needed to light the indicator. On the other hand, a "Go" signal causes the same timer contact to be connected, so that, if the switching circuits should fail before the next test is selected;

more on page 215

**FROM TAPCO...**

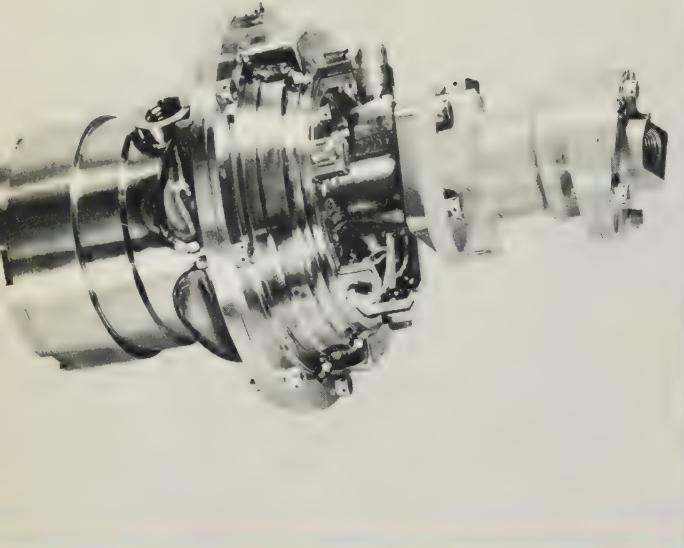
# **Secondary Power Systems**

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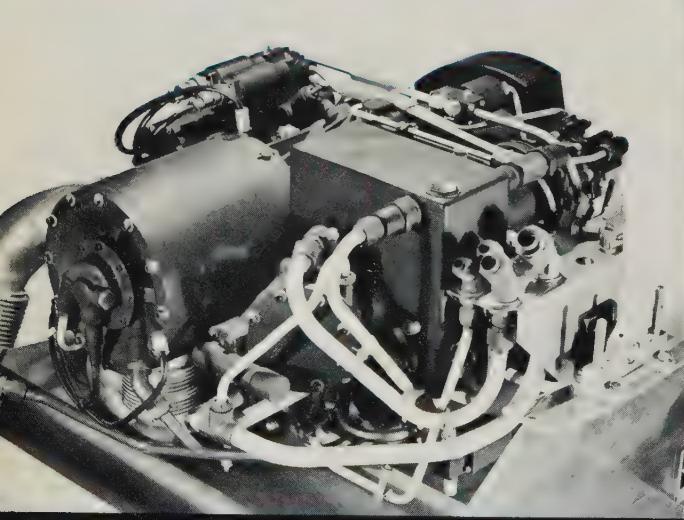
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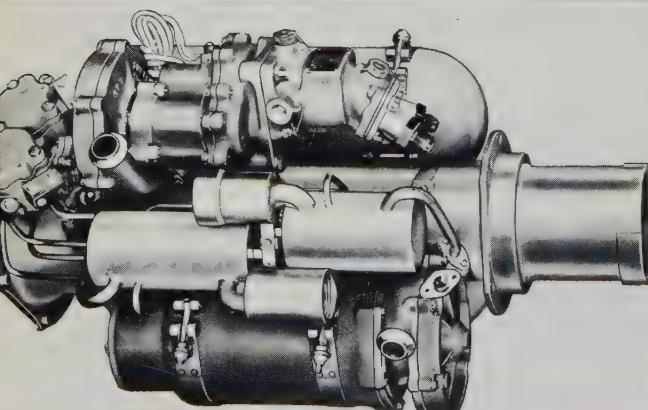
# Secondary Power System using any energy source for any power output



New TAPCO-developed UNIPUMP is a solid fuel, self-regulating, single-shaft turbo-hydraulic supply. Capacities from 1 to 5 gpm at 3000 psi for durations up to 3 minutes.



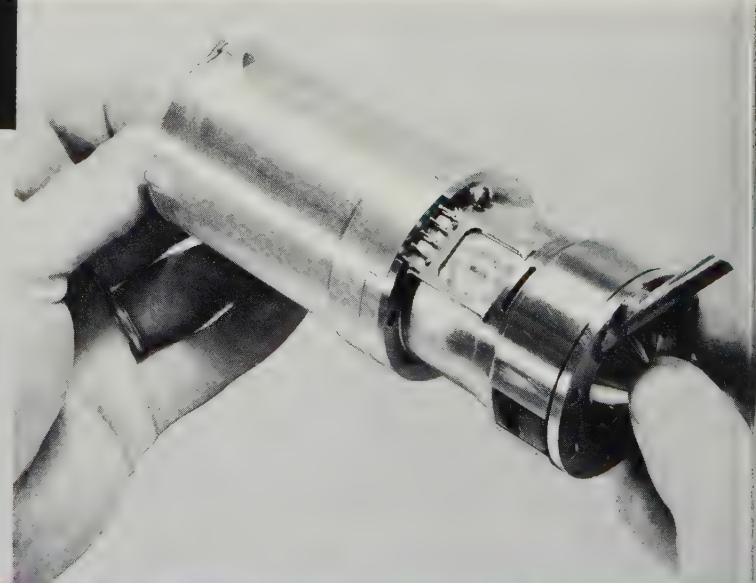
This TAPCO Auxiliary Power Unit, driven by a 4-stage solid-fueled turbine, produces 70 HP to generate 40 kva. of electricity and to drive a hydraulic pump for actuating controls.



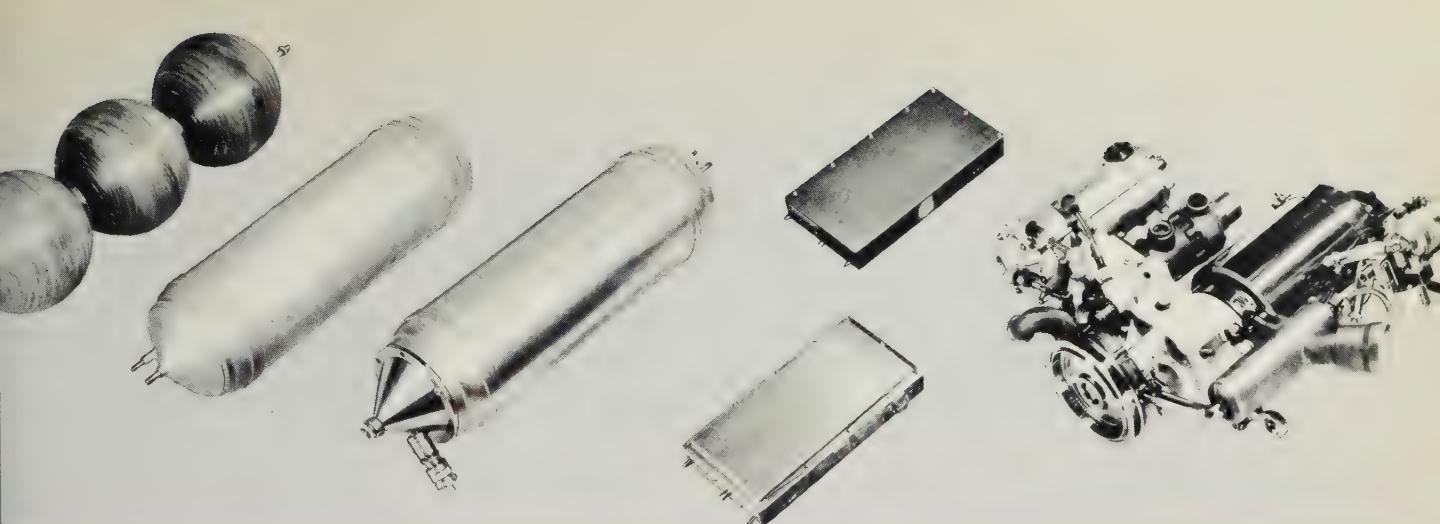
Solid-fuel self-contained electrical and hydraulic power supply designed and developed by TAPCO. Solid-fuel versions of these auxiliary power supply units are being used in Terrier missiles.

Here you see a few of the secondary power systems developed and built by TAPCO for leading missile and aircraft manufacturers. These systems provide power for flight control and generate electrical energy with precisely-controlled frequencies as low as  $\pm .001\%$ .

Some TAPCO secondary power systems operate in high-temperature ambients. Others operate in the cryogenic range. Our half-century of experience in producing precision components to function reliably in abnormal ambients is especially important.



MINIAPS, a new TAPCO-developed solid-fuel miniature turbo generator provides up to 200 watts of power. This multiple output concept supplies precise voltages and frequencies, in both AC and DC current for missile fuzing and telemetering applications.



Auxiliary power unit designed by TAPCO to provide all electrical and actuation power for the advanced Bomarc missile. This is a completely self-contained

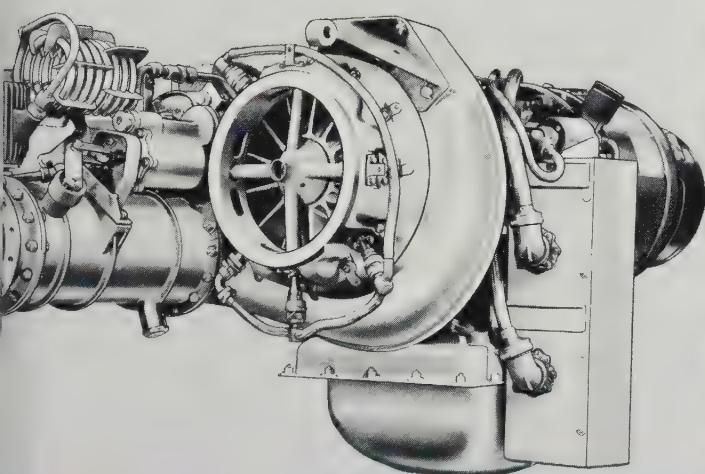
package system which requires only a start signal to provide power for the missile during flight. It meets unusually difficult environmental conditions.

present-day and future applications. Also, our experience with metals and materials to resist the effects of corrosive liquids and gases is vital in producing turbines and power system components that are in contact with unusual combustion conditions resulting from liquid and solid propellant gas generators.

Some secondary power applications more economically use bleed or ram air as an energy source. TAPCO's broad background in the development of air turbines is valuable in applications of this type.

Years of experience in developing all types of pneumatic, electronic and mechanical controls is still another part of TAPCO's secondary power system capability. This includes rotating electrical machinery and electronic and electrical speed controls with transistorized components.

Advanced research is now underway at TAPCO to determine the secondary power systems of the future. This activity includes the investigation of such new energy sources as fuel cells, solar power and nuclear power.



Air-driven turbine and 60-kva alternator with TAPCO-designed controls that hold 400-cycle current to  $\pm 1\%$  stability in compounded operation.



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For designing and developing secondary power systems for new applications, the TAPCO Group includes stress analysts, ceramicists and metallurgists, combustion engineers, computer programmers, and a score of other talents. A new project or idea can be staffed promptly with experts from the 1250-man TAPCO engineering group.

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In addition, when very unusual projects require it, the research people and facilities from the TRW staff and the 11 other TRW divisions can be called on.

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Complete facilities and manpower are available in the TAPCO Group for simulation, certification and pre-delivery testing equipment built by TAPCO.



TAPCO's 1105-acre Roanoke Test Facility can run tests involving high-G, very-high temperatures, supersonic sound, high-amplitude vibration, high-radiation, shock, and high-altitude conditions, any combination. Shown below are some of the environmental buildings, with Rubber Cartridge air to handle simulated accelerations from 0 to 60 G's and package sizes up to 600 lbs.



## TAPCO GROUP

*Thompson Ramo Wooldridge Inc.*

CLEVELAND 17, OHIO

DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES



the "Tester Fault" light will be energized.

The tester's amplifier is a high-gain, dc, chopper modulation type. It drives a relay through a phase-sensitive demodulator and a transistorized current amplifier. Each time a "Go error" signal causes the "Go" relay to operate, a trial "No Go" signal is connected to the amplifier input; the switching circuits then wait for a "Go" relay dropout before advancing to the next test.

This arrangement positively insures that the amplifier and "Go" relay are restored to their "No Go" condition before each test is begun. If the "Go" relay fails to drop out, the incomplete switching cycle causes the "Tester Fault" light to go on, and the test sequence stops.

In the relay circuits, about a dozen relays control program-stepper advancement and memory, selection stepper advancement, contact protection interlocking, non-stepper test, test step bypass, error signal polarity, and the like. These circuits are designed for minimum dependence on relay pickup and dropout time by means of contacts interlocked so that the start of each relay control action must await the completion of the appropriate preliminary actions. The basic timing cycle is therefore sequential instead of synchronous and is well suited to the driving circuit arrangement of the stepping switch.

The continuity and insulation tests check the wiring. Relay contacts may be checked in both energized and de-energized positions by using continuity and noncontinuity tests. Additional simultaneous contacts at 28 V dc can be used for programming relay operations.

The close-tolerance maximum-and minimum-resistance tests are used for checking resistors and motor and synchro windings as well as for making special continuity or insulation tests. For each programmed value, a 0.1 per cent wire-wound resistor is mounted inside the plugboard. The test range can be extended down to one ohm or up to 150 K at reduced accuracy.

A built-in zener reference is used for the diode checks. The diode-reverse tests are made at the same contact points as the diode-forward tests, so that an open or shorted diode will be rejected. The time delay test was provided for a requirement of the Jupiter main distributor. Write in No. 63 on Reader Service Card for more data.—JH

## THE *Silwhite* Industrial Airbrasive® Unit

Not that we advise doing this to your fine crystal glassware, but it seemed to us a dramatic way to show you the versatility and the cool, shockless cutting and frosting action of our Industrial Airbrasive Unit.

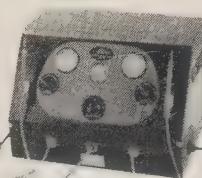
Cuts as fine as .008" or large frosted areas are equally easy to make with this amazing industrial tool. A gas-propelled stream of abrasive particles quickly slices or abrades, as needed, almost any hard, brittle material, such as fragile crystals, glass, oxides, metal, minerals, ceramics.

Applications range from printed circuits, wire-stripping potentiometer coils, and cleaning off oxides...to shaping or drilling germanium. Every day new uses for the Airbrasive Unit are being discovered.

*Send us your most difficult samples and we will test them for you.*



SEND FOR  
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New dual Model D!

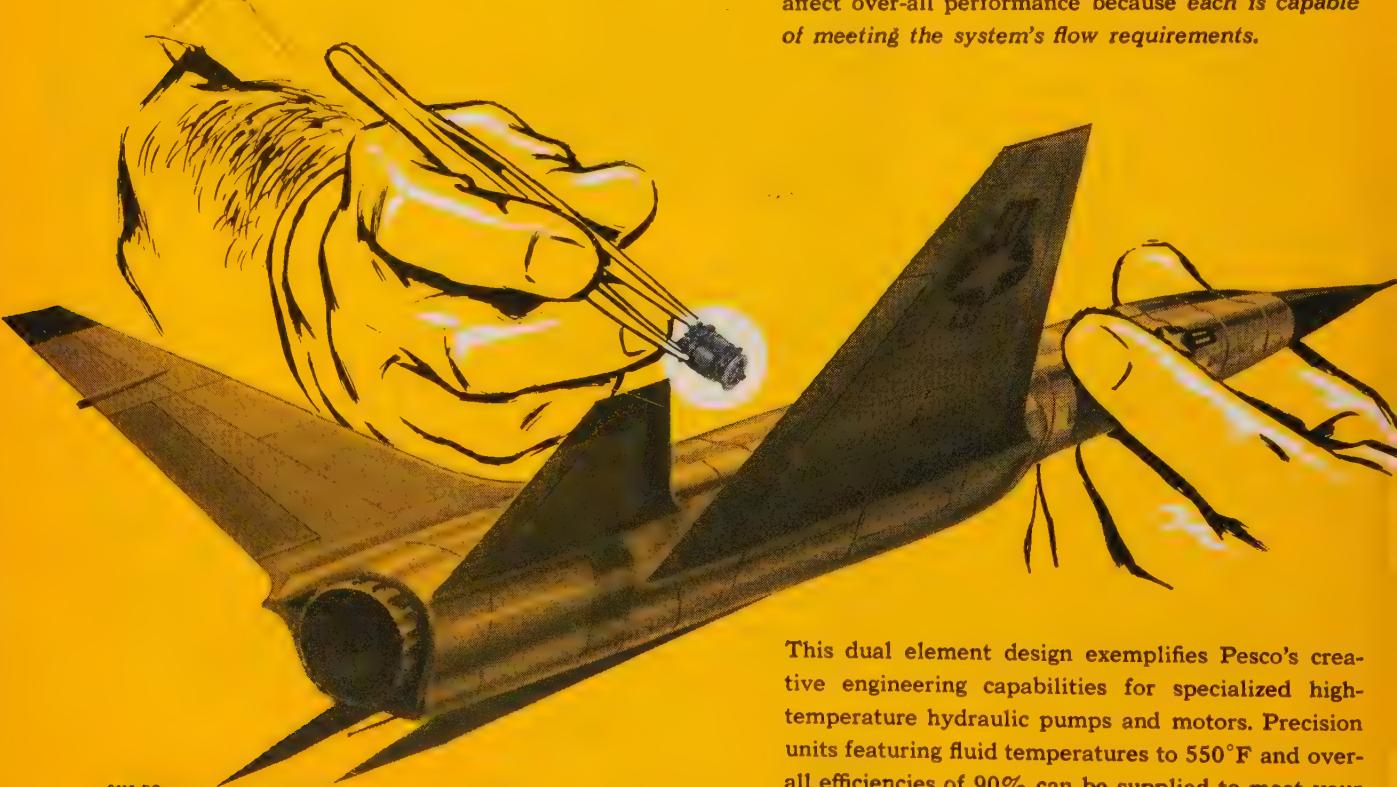
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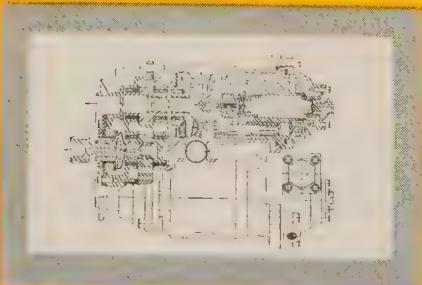


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FOR FAIL-SAFE OPERATION!**

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8697-PC



Operating on 25-100 psig inlet press. and 550°F inlet temp., this PESCO Dual Element Design discharges 21.5 gpm at 4000 psi.

This dual element design exemplifies Pesco's creative engineering capabilities for specialized high-temperature hydraulic pumps and motors. Precision units featuring fluid temperatures to 550°F and overall efficiencies of 90% can be supplied to meet your specific requirements. For details, call your nearest Pesco representative or write direct.

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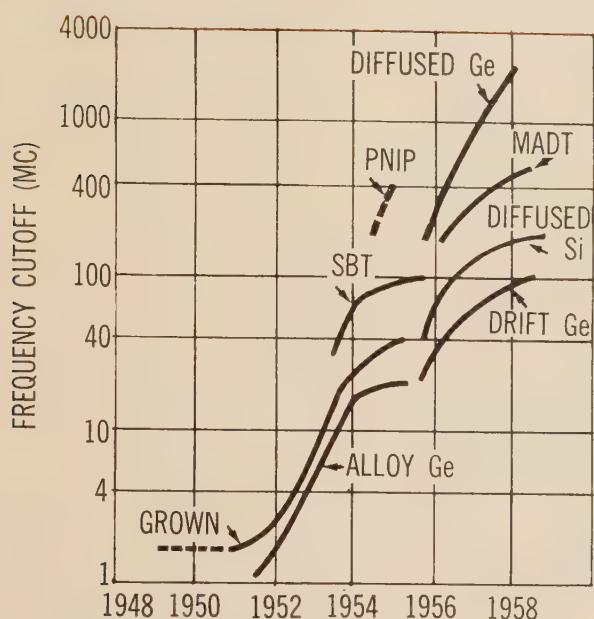
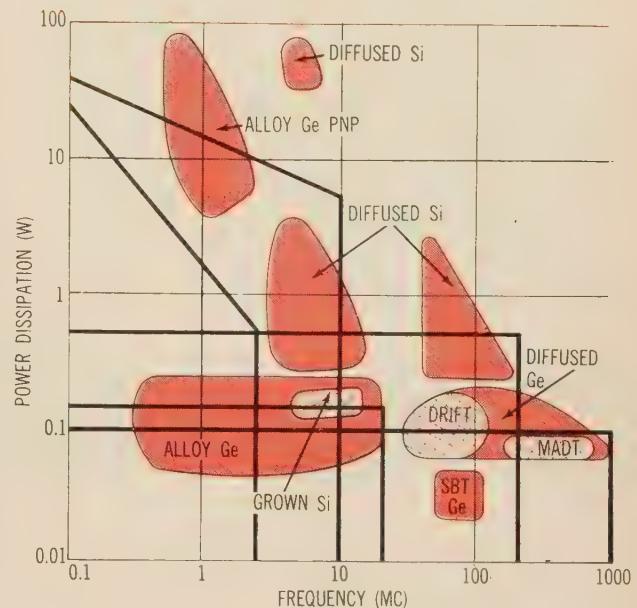


FIGURE 1: Trend in frequency performance (left) of transistors.



transistor types. The contours show the overall performance ranges.

## What's ahead for junction transistors?

Since 1948, we've put about 2000 engineer-years into transistor design. Now the time has come, this article argues, to start freezing some of the designs and concentrate on boosting production.

by J. J. Ebers, late Assistant Director of Development,  
Allentown-Laureldale Laboratory, Bell Telephone Laboratories<sup>1</sup>

TRANSISTOR production has nearly doubled every year for several years now. In 1958, 50 million units were produced. By 1965, annual production should reach at

least 300 million units (as against 400 million for electron tubes).

Just what the future holds for the conventional three-region, three-terminal transistors is perhaps best seen in the answers to these questions:

- Can transistors be brought to a performance level at which they can do 95 per cent of the jobs they ought to do?

- Are we reaching a technological "plateau" so far as transistor application is concerned?

- Can satisfactory transistor life be had?

- How will transistor costs develop?

- How will production be divided among transistor types in 1965?

It's a fact that only over the last 4-5 years have transistors become available that can actually

more on next page

(1) Allentown-Laureldale Laboratory, Bell Telephone Laboratories, Allentown, Pa.

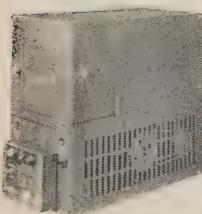
# HEAT in military applications



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#### MODEL UH-68

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Corps of Engineers' Expansible Body Program, AN/GPQ-T1 Air Force Trainer Radar and many other end item projects in the GCA category • also custom-engineered for the Matador Missile System communications shelters.



**MODEL DH-73:** 50,000 BTU/Hr. • for guided missile ground control equipment.

**MODEL UH-73-2:** 50,000 BTU/Hr. • used in U.S. Signal Corps AN/MSG-4.

**MODEL UH-58-SC-1A:** 60,000 BTU/Hr. • used in S-44, CPN/18A, MPS/7, M-109, etc.

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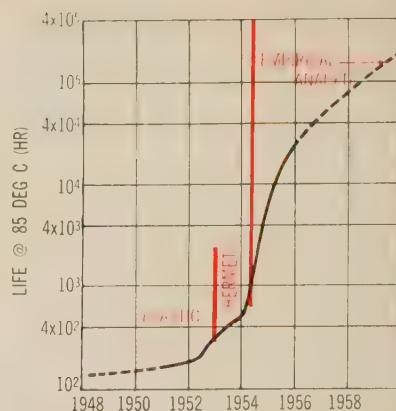


FIGURE 2: Trend in transistor life and the "ages" of transistor development.

perform most of the functions they may be required for, as in high speed pulse, video, VHF, and UHF amplifiers and oscillators. During this relatively short period, the frequency cutoff of grown junction transistors was extended up to as much as 40 mc by the combination of methods like rate growing, melt-back, and diffusion with growing (Fig. 1). Conventional alloy transistors are still limited to base widths of about 0.3-0.4 mil, which corresponds to a frequency cutoff of about 20 mc.

#### Major advances scored in 1953 and 1954

Philco's 1953 surface barrier transistor and the 1954 microalloy device represented major advances—it became possible to accurately control extremely thin base layers by means of an electrolytic etching process. At about that time, Bell Lab's J. M. Early, who had recognized that electric punch-through of the base layer was the big obstacle in getting higher frequencies, was working on a PNIP device. H. Kroemer was showing that frequency performance could be upped by providing a drift field in the base region through a graded impurity distribution.<sup>2</sup> These developments led to the drift transistor and later to the microalloy diffused transistor (MADT).

In 1954 and 1955, Bell Labs demonstrated the feasibility of diffused transistors, which pointed the way to the mesa device. By 1958, both germanium and silicon de-

(2) U.S. Patent 2,739,088, to W. G. Pfann, **more on page 220**

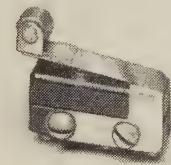


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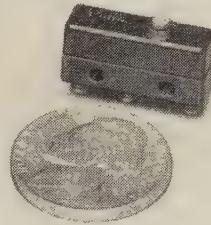


Lever type actuator for use with low operating force



Roller type actuator for use with two Type "SM" switches

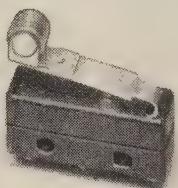
Basic "SM" switches are available in over 300 different variations



Leaf type actuator for use with two Type "SM" switches



Integral leaf actuator for use with slow-moving cams and slides

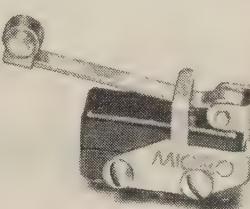


Integral roller-leaf actuator for use with fast moving cams and slides



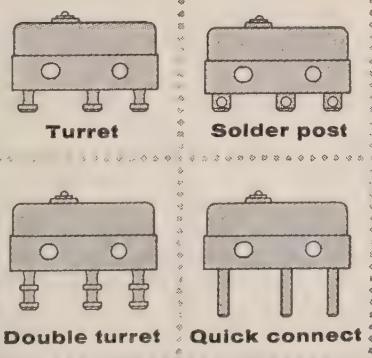
Leaf type actuator with special bend to follow slow-moving cams or slides

Roller lever actuator for high-speed, low-friction applications



## Ten different ways to actuate this small, dependable switch

### ACTUAL SIZE



"SM" switches are available with these four kinds of terminals

Here are ten "SM" subminiature switches equipped with ten different integral and auxiliary actuators that contribute to the great versatility of these dependable, small switches. For ten years MICRO SWITCH subminiature switches have been the choice of designers who require switches of high electrical capacity which can be mounted in small space.

For complete information on the MICRO SWITCH lines of subminiature and sub-subminiature switches, we invite you to contact your nearby MICRO SWITCH branch office, or send for Catalog 63.

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# Honeywell

MICRO SWITCH Precision Switches

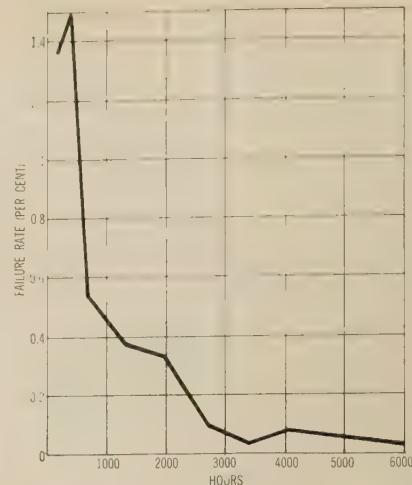
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vices could be made with frequency cutoffs of over 100 mc. Germanium types went as high as 1000 mc (Fig. 1).

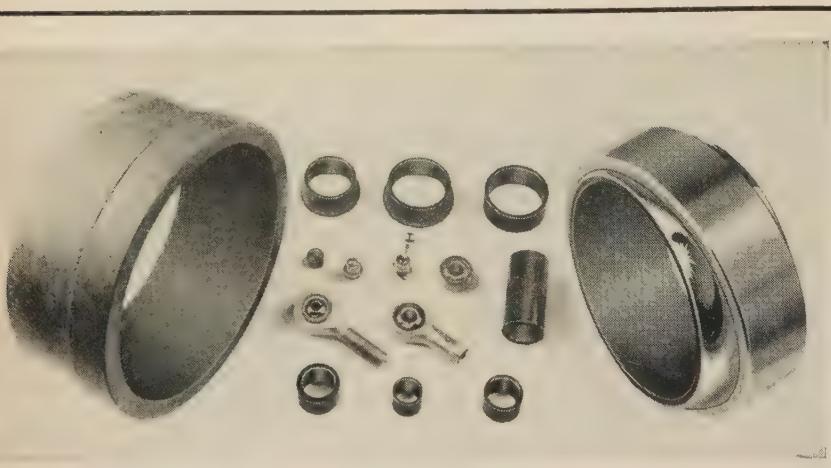
It would appear that the transistor technology has indeed advanced to the point at which we have or can design devices that will in fact do about 95 per cent of the required jobs. There also don't seem to be any new technologies coming along that will have a major effect on the types

of transistors to be produced in the next five years. It's fairly safe to say that we have finally reached a first transistor "plateau."

Figure 2, showing the life performance of various transistor types, gives a history of transistor reliability. In 1952, or near the end of what we might call the "Plastic Age" of transistors, it was discovered that the transistor is extremely sensitive to moisture effects. In 1953, hermetic sealing



**FIGURE 3:** Instantaneous failure rate of NPN alloy transistors for about 2000 units under simulated operating conditions.



## SELF-LUBRICATING FABROID BEARINGS

solve acute bearing problems

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- ★ Contamination
- ★ Tight space, weight conditions
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**Reduce—costs, wear, maintenance, and friction**

**Eliminate—lubrication, fretting, brinelling, use of seals**

\*E.I. DuPont's Tetrafluoroethylene

U.S. Patent Nos. 2,804,886; 2,835,521; 2,885,248

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was proved to be a better method of transistor encapsulation, and we entered the "Hermetic Age." There was an immediate but only slight improvement in reliability. The trouble was that significant amounts of moisture were still being sealed into the can during the sealing process.

Then we found out that transistors deteriorate during high temperature aging. But we also learned that they could be brought back to life if we punched a hole in the can to release some of the moisture. By 1954, it was clear that reliability could be improved very significantly by careful processing.

#### Better reliability in "Empirical Age"

Next in the history of the transistor came the "Empirical Age"—very big improvements in reliability were made by controlling the internal ambient, but we actually knew little about the fundamental processes involved. By 1956, though, enough work had been done on fundamentals, to enable us to explain the surface action on the semi-conductor, including the roles of water vapor and O<sub>2</sub>, in terms of channels, inversion layers, surface recombination velocity, surface states, etc.

The curve in Figure 2 is solid up to only about 20,000 hours simply because enough time hasn't yet gone by to prove longer life.

more on page 222

# Arc Resistance with Synthane Laminated Plastics



Resistance to arcing is important in such applications as terminal boards, switch and fuse blocks, and circuit breakers. Usually, however, arc resistance alone is not sufficient to satisfy job requirements. Ceramics, for example, are excellent for arc resistance but they break easily and are difficult to machine. Mica has excellent arc resistance yet lacks strength.

## Laminates have arc resistance plus

Laminated plastics have many desirable properties in combination. All grades of plastic laminates have good electrical properties. All have good dielectric

strength, dissipation factor and insulation resistance. Some laminates also have excellent arc resistance and some—the phenolic laminates, for instance—are relatively poor in this respect.

It is this failing of the phenolic grades which may have deterred you from thinking of laminates when arc resistance was required. But, outstanding progress has been made to supply laminates with excellent arc resistance. For example, Grades CM, LM, G-5 and G-7 have outstanding arc resistance properties.

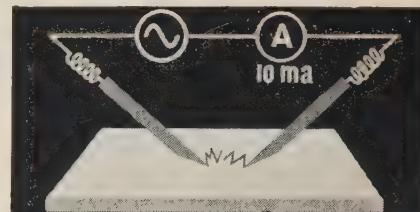
There are several tests for arc resistance. One commonly used is ASTM Method D495-56T, which approximates service conditions in alternating current circuits operating at a high voltage, with currents limited to units and tens of milliamperes. Two pointed electrodes,  $\frac{1}{4}$ " apart (see drawing), rest upon the material to be tested. The arc is applied intermittently, and at first mildly. Later the time between flashes is decreased and the amperage is increased until the arc finally burns a conducting path between the electrodes. The total time in seconds until failure occurs is the arc resistance of the material.

## Arc resistance is related to time

Since the severity of the arc is progressively increased, the comparative arc

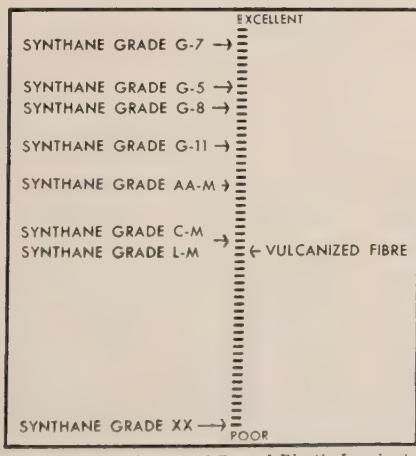
resistance of two materials is not in direct proportion to the time. The accompanying chart gives you a fairly accurate relationship of the arc resistance of Synthane laminates—using the ASTM method. The first four are glass base grades. G-7, containing a silicone resin, tops the list in arc resistance as well as in dielectric strength, dissipation factor, insulation resistance and moisture resistance.

For specific information relating to Arc Resistance for your application or for the combined properties of Synthane laminates, write Synthane Corporation, 55 River Road, Oaks, Pa.



Set-up for A.S.T.M. Arc Resistance Test in the Synthane Laboratory.

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Relative Arc Resistance of Several Plastic Laminates and Vulcanized Fibre.

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# another first from ELECTRO TEC

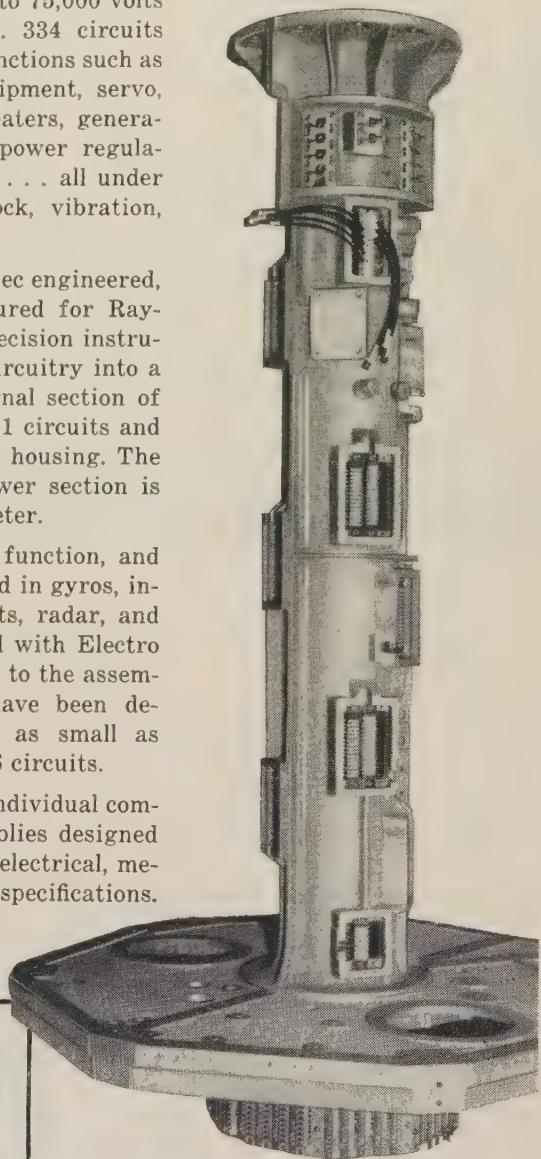
## critical slip ring assembly for TARTAR MISSILE RADAR TRACKING UNIT

**THE PROBLEM**—Means was required for the uninterrupted transmission of power and signals through a rotating joint to a revolving antenna. Power requirements were extremely high—up to 75,000 volts—and space was limited. 334 circuits were involved in diverse functions such as operating TV camera equipment, servo, and synchro equipment, heaters, generators, de-icing equipment, power regulators, and hydraulic pumps . . . all under extreme conditions of shock, vibration, and humidity.

**THE SOLUTION**—Electro Tec engineered, prototyped, and manufactured for Raytheon a highly sensitive precision instrument that packs a lot of circuitry into a small unit volume. The signal section of the slip ring consists of 331 circuits and is 6 feet tall complete with housing. The base which houses the power section is 3 feet tall and 52" in diameter.

Many other unique space, function, and reliability problems involved in gyros, inertial guidance, instruments, radar, and switching have been solved with Electro Tec slip rings.\* In contrast to the assembly for Raytheon, units have been designed and manufactured as small as .039" diameter containing 6 circuits.

Write for information on individual components or complete assemblies designed to meet the most stringent electrical, mechanical and environmental specifications.



\*Patent No. 2,696,570  
and other patents pending.

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TRANSISTORS . . .

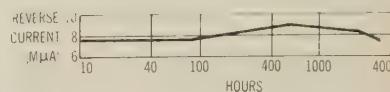
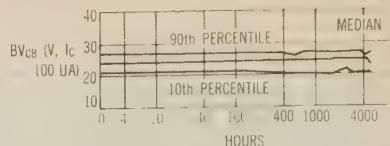


FIGURE 4: Power aging at 80 deg C and  $I_B = 0.4$  ma and  $I_C = 10$  ma for mesa transistors (top) and reverse-current aging for diffused silicon diodes (bottom).

However, it's probably safe to predict that the median life of transistors now in production or final development will go over 1,000,000 hours.

Figure 3 shows the instantaneous failure rate for about 2000 transistors in a simulated-operation test. The data are for two-year-old, NPN alloy junction devices, and the test was run for about 6000 hours. Though the failure rate started out at a relatively high level, it dropped to an average of 0.2 per cent failures per 1000 hours, corresponding to an average life of  $4.4 \times 10^5$  hours.

### Lower failure rates for mass applications

For the many applications that may involve thousands of transistors, it will be important to have devices with failure rates of 0.1 per cent per 1000 hours or less. To get this improved life, such high reliability procedures as the following must be used:

- Etch the transistor element before mounting it.
- Use ultrasonic and cascade washing to reduce contaminants.
- Use alloyed or thermocompression bond contacts (no solder or flux).
- Vacuum-bake piece parts.
- Use cold weld or low temperature seals.
- Tubulate and vacuum-bake assemblies.
- Keep proper ambient limits inside the case.

Figure 4 gives aging data on modern high reliability diodes and transistors. It's becoming increasingly clear that you can make

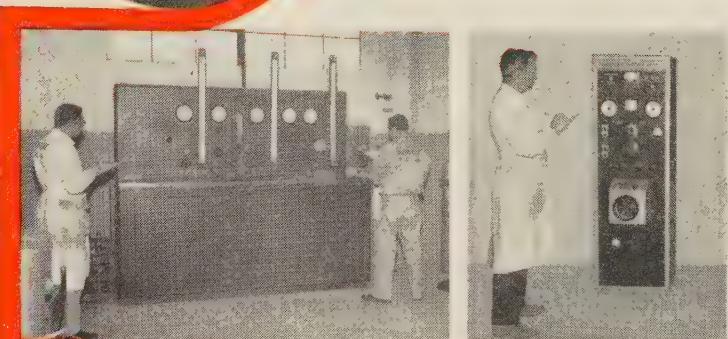
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SPACE/AERONAUTICS

*from conception*

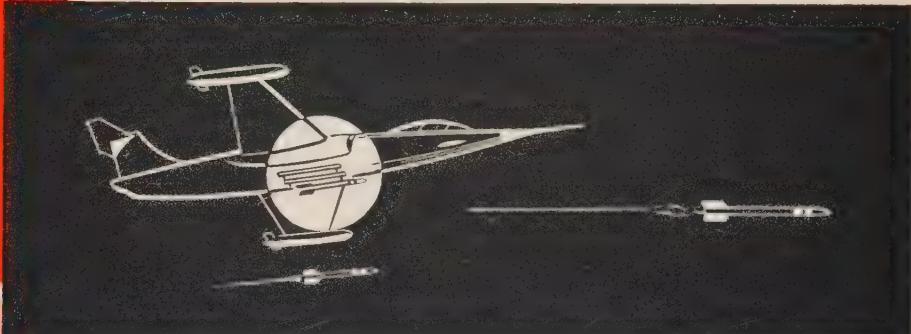


*thru research and development*



*thru mass production*

*to operational use*



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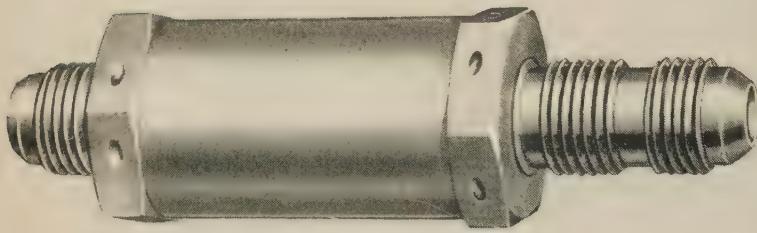
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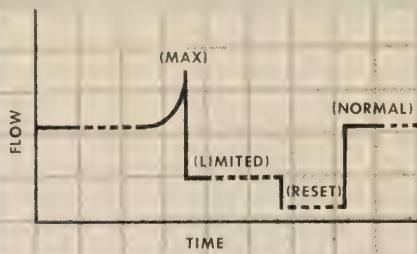
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- Operating pressure: 3000 psi.
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- Pressure drop across valve: 20 psi (max) for flow of 2.2 gpm.
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- Construction: all stainless
- Ports: MS 33656-6 Inlet AND 10057-6 Outlet
- Bulkhead fitting on outlet port.
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## TRANSISTORS . . .

### Diffused Germanium Transistors

Medium power VHF amplifier  
Video or UHF amplifier  
High speed switch  
UHF oscillator

### Diffused Silicon Transistors

High speed switch (NPN & PNP)  
High current switch (NPN)  
Linear UHF amplifier (NPN)

### Alloy Germanium Transistors

Low power amplifier  
Power amplifier

### Diffused Silicon Diodes

1/4-, 1- & 10-amp rectifiers  
1/4-, 1- & 10-W voltage limiters  
High speed, high current  
Ultra-high speed

transistors with a failure rate of less than 0.01 per cent per 1000 hours, or a median life of  $10^7$  hours.

### Reliability is still too costly

However, transistor designers are not satisfied with the cost of this kind of reliability. Certain of the procedures that are now necessary—probably will be eliminated in time.

The production cost of any electronic component (or of any component, for that matter) is tied closely to the complexity of the device. Take, for example, a commercial pentode electron tube. The tolerances for the 30-odd piece parts of this tube are in mils or fractions of mils. During assembly, the spacings of the piece parts must be stringently controlled.

### Tubes provide example of cheap production

Generally, the tube manufacturer hand-assembles the piece parts on the header. Then header and tube envelope are placed in a Sealex machine, in which the tube is sealed together, evacuated and degassed, the cathode is activated, the getters are flashed, and the tube is sealed off. About 10-20 million of these units are produced each year, and the device usually sells for a little over a dollar.

Now, let's look at the mesa

more on page 226

*Economies in equipment size, weight, and power consumption begin with...*

RCA **PPM** TRAVELING-WAVE TUBES  
for **X-Band** operation



RCA Dev. Type 1140 PPM Traveling-Wave Tube—cut away to show self-contained periodic permanent magnets

RCA TRAVELING-WAVE TUBES FOR X-BAND OPERATION							
RCA Type No.	Frequency (MC)	Typical Performance		Duty Factor	Focusing Method	Approx. Size	
		Power Output	Low-level Gain (db)			Weight (lb.)	Length (in.)
A-1140	8000-12000	10 mw	40	CW	PPM	5 1/2	14
A-1133	8000-12000	1 w	35	CW	PPM	6	15
A-1181	7500-11200	50 peak watts	35	0.05	PPM	6	14

RCA Microwave-Tube Engineers invite inquiries for customized versions

RCA's continuing program to provide designers with a comprehensive and reliable line of traveling-wave tubes is exemplified by three new PPM focused X-band TWT's.

Focusing by means of Periodic Permanent Magnets makes possible more compact and lighter equipment designs. Waveguide couplings significantly reduce power loss, improve performance and efficiency in

this complimentary family of developmental X-band traveling-wave tubes for ECM, drone target systems, and radar applications. And all three tubes are designed for high-altitude airborne operation.

For traveling-wave tubes in any application in the L, S, C, and X bands, call the RCA Field Office nearest you. Your RCA Field Rep-

resentative will be happy to give you detailed information on RCA commercial and developmental types—or customized versions—for your specific system needs.

GOVERNMENT SALES

HARRISON, N. J.  
415 S. 5th Street, HUMBOLDT 5-3900  
DAYTON 2, OHIO  
224 N. Wilkinson St., BALDWIN 6-2366

WASHINGTON 6, D. C.  
1625 "K" ST., N.W., District 7-1260

INDUSTRIAL PRODUCTS SALES

DETROIT 2, MICHIGAN  
714 New Center Building, TRINITY 5-5600

NEWARK 2, N. J.  
744 Broad St., HUMBOLDT 5-3900

CHICAGO 54, ILLINOIS  
Suite 1154, Merchandise Mart Plaza,  
Whitehall 4-2900

LOS ANGELES 22, CALIF.  
6355 E. Washington Blvd., RAYMOND 3-8361



**RADIO CORPORATION OF AMERICA**

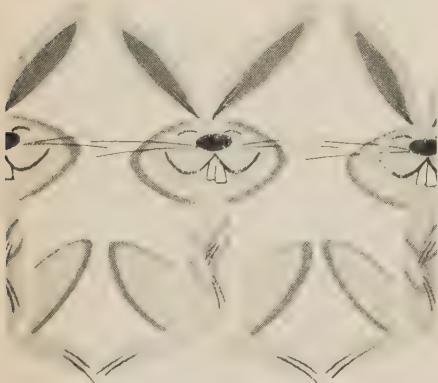
Electron Tube Division

Harrison, N. J.

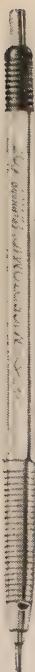
# The difference in



## MICROTOMIC DRAFTING LEADS



is that they're all alike!



The point is—a Microtomic 2H is a 2H is a 2H . . . regardless of where or when it was purchased.

The consistent uniformity of degree in MICROTOMIC Leads is one direct result of EBERHARD FABER's pencil quality control which also results in unusual point strength . . . sharper, blacker lines. They're sure-fired—at 10,000 degrees F.—for smooth drafting! In 17 consistently graded degrees . . . one dozen to flip top box with handy point sharpener. Use with MICROTOMIC Lead Holder. You'll agree it has a grip that's great!

Tm. Reg. U.S. Pat. Off. and Other Countries

110th Anniversary, 1849—1959

**EBERHARD FABER**

WILKES-BARRE, PA. • NEW YORK • TORONTO, CANADA

Write in No. 152 on Reader Service Card

## TRANSISTORS . . .

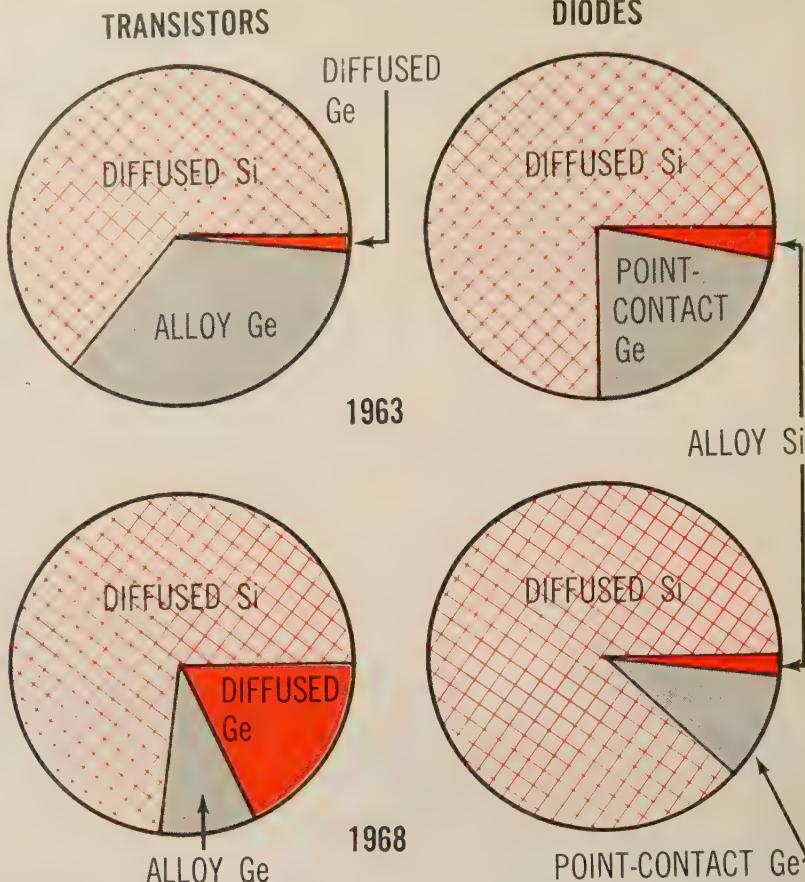


FIGURE 5: Production trends for diodes and transistors.

transistor. We have estimated that the diffused, evaporated, etched element for this device can be made for about 10 cents. The element must then be mounted on a header, leads must be attached, and the unit must be properly sealed. Once production levels have increased enough so that more automated machinery is feasible—particularly for the attaching leads—there's no reason why the device shouldn't sell for considerably less than the comparable tube.

### Few codes raise the production level

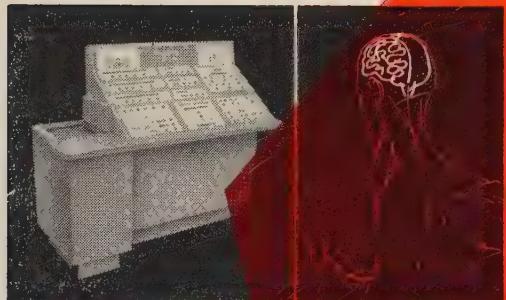
One of the best and simplest ways to get high production levels is to keep the number of codes to a minimum. Certainly the designer can afford to add 10 cents' worth of complexity to his circuitry if he can save 20 cents on the cost of the transistor. Over the past year or two, the results of a close study of this major problem have led us at Bell Labs to develop a "preferred-devices" list for our own

purposes. These devices have a range of performance wide enough to meet the needs of most circuit applications (see Table).

For low-power, alloy germanium transistors, we're now allowing five different codes. *But all these codes use the same manufacturing facilities.* In time, it should be possible to add one, two, or even three variations of new codes to each prototype family to keep the testing to a minimum.

As part of the same preferred-devices program, a survey was made to find out how many devices of each type would be needed over the next few years (Fig. 5). This division may not be representative of the entire industry, but on the other hand the Bell System has all kinds of applications—linear and non-linear, switching and non-switching, and covering a wide range of frequencies. In our case, at least, by far most of the devices in use by 1965 are expected to contain diffused mesa transistors and diffused silicon diodes.—End

# On the verge of failure



ERCO creates  
experience



Columbus' entire voyage faced one crisis after another... and for lack of intermediate information, was very nearly destroyed by a mutinous crew. A crew suffering from the shock of new experiences... and having only the unknown to look forward to.

Today there is no need for man to face these experiences unprepared... and in the case of the military, it is costly from the standpoint of time and money to learn through actual experience the operation of complex equipments which make up our nation's defenses.

Theory represented by scientific formula is passive... and as in Columbus' case, it does not include the moment-to-moment experience. ERCO, through unique special-purpose computers, transforms the inert equations into active environments with almost every conceivable experience... and the opportunity for a man to live and re-live an event hundreds of times before it ever happens.

ERCO ability and leadership in the area of special-purpose computation has as its foundation hundreds of real experiences creating and building systems and equipments which give precise reproductions of what will happen.

For a prompt engineering review of your project write Manager-Marketing

**ERCO**  
DIVISION **ACF** INDUSTRIES INC., RIVERDALE, MARYLAND

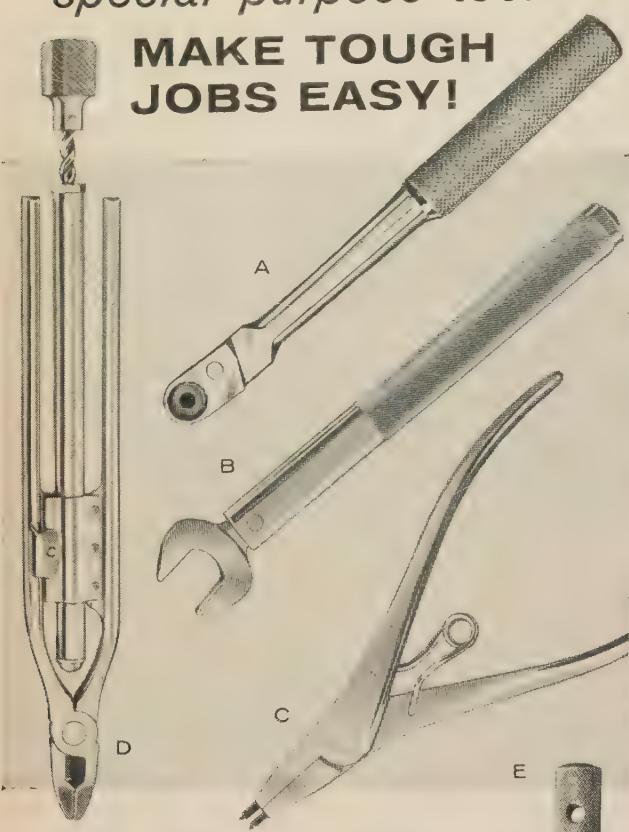
OTHER **ACF** DIVISIONS: ALBUQUERQUE • AMERICAN CAR & FOUNDRY  
AVION • CARTER CARBURETOR • SHIPPERS' CAR LINE • W-K-M

Write in No. 154 on Reader Service Card at start of Product Preview Section

# MILBAR

special purpose tools

MAKE TOUGH  
JOBS EASY!



**A. MILBAR CLOSE-CLEARANCE RATCHET WRENCH**—for tightening or removing twelve-point or hex-head screws and nuts. Fits in the tight spots where regular wrenches won't work. Smooth ratchet action. Several sizes available. Widely used in aircraft and missile industries.

**B. MILBAR SNAP TORQUE TOOL**—with pre-set torque. A "click" you can feel and hear tells when proper torque is reached. A choice of head types for specific jobs. Widely used on production lines in the automotive and aircraft industries.

**C. MILBAR SNAP RING TOOL**—the original and most widely used tool with replaceable points of different shapes and sizes. Tool lasts forever—just change points for the job at hand or when they wear out. Special points for holeless snap rings.

**D. MILBAR WIRE TWISTER**—for smooth, automatic one-hand operation. Extra large serrated jaws assure a longer life and non-slip grip. Spring return and squeeze release eliminates need for shifting hands. Twists and cuts wires with no waste motion.

**E. MILBAR GEARED RIGHT-ANGLE TOOL**—for easy access to "tight" spots. Fits all standard  $\frac{3}{8}$ " drive extensions, sockets and ratchets. Reaches around corners and delivers increased torque for tightening or removal. Eliminates unnecessary removal of parts to get at the job to be done. Fully proven and tested by thousands of users.

Send for your free brochure describing these, and other, MILBAR Special Purpose Hand Tools. MILBAR has the engineering facilities and personnel to solve your special problems where sufficient volume is involved.

**MILBAR**



**CORPORATION**

1900 EUCLID AVENUE

CLEVELAND 15, OHIO

Write in No. 155 on Reader Service Card

## electronics scanner

**WESCON SHOW**, held in San Francisco, Calif., Aug. 18-21, had new system for its technical sessions: At each session was a panel of three members familiar with the areas covered in the session's papers. Following the presentation of the papers, the panel members made comments and asked probing questions. Often this led to lively discussions involving authors, panel, and audience.

The new technique appeared to make the sessions much more lively. It should also lead to better papers—knowing their work will be reviewed by experts right in front of their audience, authors might go in for a little more polishing of their manuscripts.

**ELECTRONICALLY SCANNED** microwave arrays using synchronous reciprocal ferrite phase shifters that operate via a synchronously rotating magnetic field were discussed at Wescon by three engineers from Rantec, of Calabasas, Calif. Such devices provide a continuously increasing phase shift that is linear in time to the same degree to which the angular velocity of the rotating magnetic field is constant. The field velocity is precisely controlled through quadrature currents in identical quadrature coils. The rate of phase change is a function of the frequency of the currents in the coil.

The technique eliminates all the non-linearity problems of conventional ferrite shifters. The scan range is adjusted by selection of dead time percentage and interelement spacing. Two-dimensional scanning can be done by a combination of frequency scan in one plane and synchronous ferrite scan in the other.

The antenna can operate on both transmit and receive with pencil or split beam patterns.

**IONIZED SHOCK LAYERS** about a re-entry vehicle can influence signal transmission and reception by:

- causing detuning of the antenna;
- affecting the antenna breakdown conditions;
- causing signal loss due to absorption, reflection, or refractive or polarization rotation;
- introducing noise into receivers;
- modifying the radar cross-section of the vehicle;
- modifying the antenna radiation pattern.

These points were brought out in a highly informative Wescon paper on "Electromagnetic Effects Associated with Hypersonic Re-Entry Vehicles," by R. F. Whitmer, of Sylvania's Microwave Physics Lab.

**IN ANOTHER PAPER**, "Evaporated Films and Digital Computers," by D. W. Moore, manager of applied research at Servomechanisms, it was noted that the high tooling costs of evaporation of materials could be justified if the materials were to be applied to a device with a large amount of repetitive circuitry—in other words, digital computers. The films specifically

mentioned by Moore are magnetic types consisting of about 82 per cent nickel and 18 per cent iron.

**A NON-GYROSCOPIC** inertial reference was described in a Wescon paper by J. J. Klein of Lockheed's Missiles & Space Div. The device, according to Klein, has an accuracy potential that can't be achieved by gyros.

The non-gyro reference is "an inertial mass placed in a controlled environment in such a way that the forces and moments acting on this body are predictable," said Klein. You therefore can reduce the effects of the disturbing forces and moments to a negligible value of servo compensation.

**KLEIN SUGGESTED** as a possible configuration a glass cylinder floated in a low viscosity fluid within a sealed container. The fluid temperature is precisely controlled. The glass cylinder is kept in place by quartz torsion bars, and the container is supported by ball bearings, with the axis of rotation coincident with the axis of the inner cylinder.

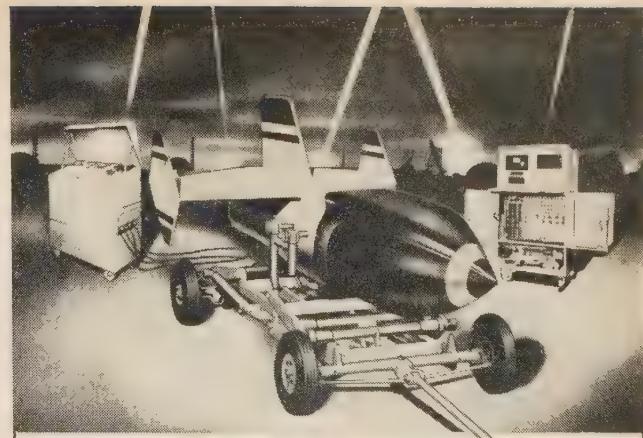
A linear accelerometer on the case provides signals to energize compensating torque motors as in a single-axis inertial platform.

**KLEIN CLAIMED** the device has excellent possibilities for space travel. The negligible gravity field in space would eliminate errors from pendulousness and density variations, he said. Drift errors would be caused only by bearing friction, incomplete torsion wire compensation, and Brownian motion. Under such conditions, drift rates of  $10^{-9}$  deg/hr could be expected, Klein calculates.

Klein revealed that most of the information presented in his paper was developed in 1951 in a government-sponsored study. He didn't make it clear why the concept of the non-gyroscopic reference has not been pushed further in the meantime.

**NEW GLIDE SLOPE** concepts for instrument landing guidance were subjects of a highly interesting paper by Abe Tatz and Fred Battle, of Airborne Instruments Lab. The paper presented a double-angle technique for obtaining distance to the point of touchdown without distance-measuring equipment. It also revealed many of the techniques AIL expects to use in its automatic landing system under development for FAA evaluation.

**A PREVENTIVE-MAINTENANCE** scheme for airborne electronics was discussed by Marine Major D. F. Milesen, attached to BuShips. Its key feature is the replacement of equipment that has been working well. The equipment to be removed and the timing of the removals are determined by a mathematical formula. The plan, Milesen stated, works best when applied to electronic systems whose operational cost of failure is high, as in all-weather interceptors.

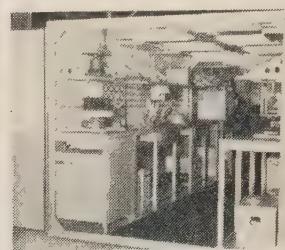
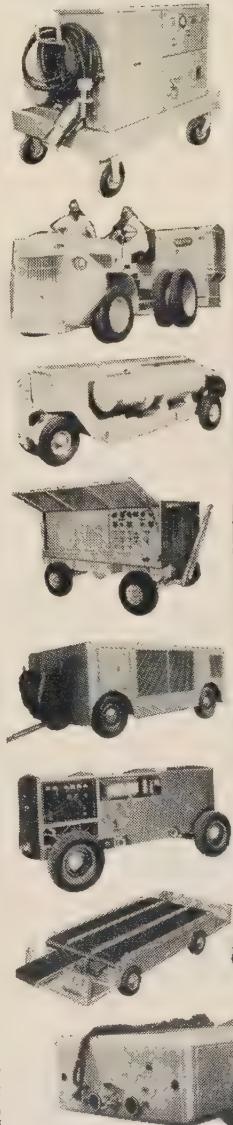


## Missile & Aircraft Ground Support Equipment

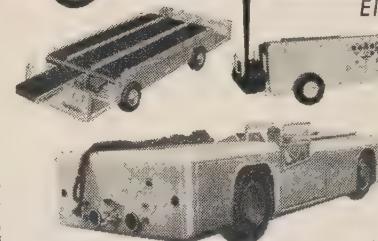
### Complete Systems:

- ▲ 400 cycle, 800 cycle and Higher Frequencies
- ▲ DC Power Supplies
- ▲ Pneumatic Power
- ▲ Hydraulic Power
- ▲ Aircraft Energizers
- ▲ Nacelle Testers
- ▲ Refrigeration, Heating & Air Conditioning
- ▲ Cargo Loading and Unloading Equipment

Competent Bogue Engineers are located near you—Call for their skills at your convenience.



Electronic Vans

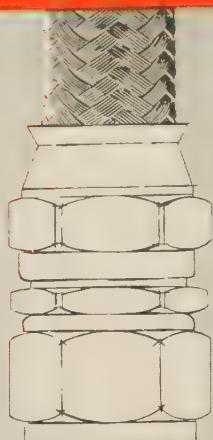


# BOGUE

BOGUE ELECTRIC MANUFACTURING COMPANY  
PATERSON 3 NEW JERSEY

Write in No. 156 on Reader Service Card

# The Aeroquip Reusable Fitting for Military and



RELIABLE/REUSABLE

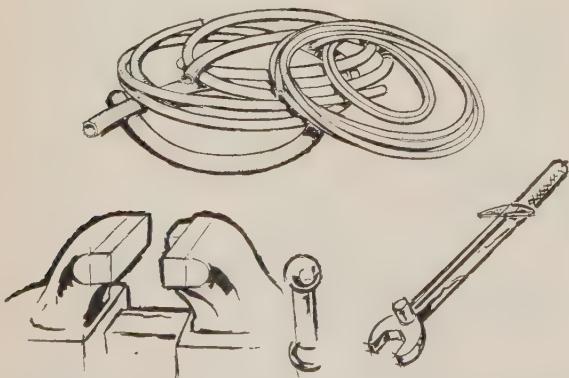
"... the logistics structure must have the inherent flexibility to respond quickly to the unexpected..."

"... we (USAF) desire to minimize the amount of stock in the system (Spares not only are costly, but become obsolete quickly) . . . "

quotes from "Logistics in the Space Age," by Maj. Gen. Frank A. Bogart, Dir. Plans and Operations, AMC, (now retired) reprinted by permission of AIR FORCE magazine, November, 1958.

## 1 Emergency Repairs Are Practical

Even at a remote air base, on-the-spot replacement of damaged hose lines is quick and simple when reusable fittings are used. The fittings needed are actually carried on the aircraft. They are the reusable fittings from the old hose lines. Bulk hose and a few simple hand tools are all that are needed to make replacement hose lines that get the aircraft back in the air in minutes.



No special tooling or swaging equipment is required. Only ordinary bench tools, always at hand, are needed to make replacement hose lines of Teflon when reusable fittings are used as original equipment.

## 2 Reusable Fittings Simplify Logistics



Pictured above are typical hose lines for a single engine installation. Imagine the thousands of different hose lengths and special end fitting configurations used throughout the services. How can the problem of logistics best be solved?

NOT with permanently attached swaged-type fittings because they make quick field repair of hose lines impossible.

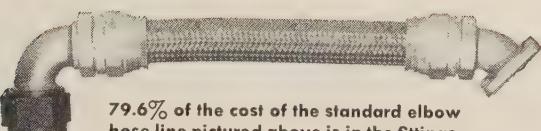
NOT by stocking made-up hose lines, for this approach is unnecessarily costly and complicates logistics.

**SOLUTION — Aeroquip "super gem"** Reusable Fittings and bulk hose provide the perfect solution for hose lines of Teflon just as Aeroquip-designed reusable fittings have become the military standards for rubber hose lines.

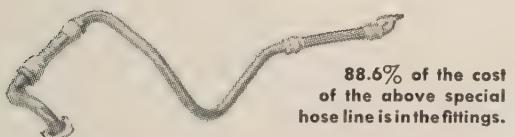


# For Hose of Teflon is a Must Commercial Applications

## 3 Reusable Fittings Save Millions of Dollars



79.6% of the cost of the standard elbow hose line pictured above is in the fittings.



88.6% of the cost of the above special hose line is in the fittings.

These examples show that fittings can be the major portion of hose line cost. When fittings are reusable, hose lines may be repaired using the same fittings. Savings are made each time the fittings are reused, and Aeroquip "**super gem**" Fittings may be used again and again.

Millions of hose lines of Teflon are now in service and millions more will be added on new equipment in the future.

When replacement is necessary why incur millions of dollars of unnecessary expense by scrapping permanently attached hose fittings?

## 4 War Experience Proved Reusable Fittings Best

The advantages of the reusable fitting are so important that these fittings were used on the 300,000 U. S. military aircraft built during World War II.

Early in World War II, the then Army Air Corps, by directive, standardized on Aeroquip Hose Lines with Reusable Fittings. In order to supply the requirements, Aeroquip gave licenses, without compensation, "for the duration" to six competitive companies. This standardization resulted in the familiar AN-MS standards for hose and reusable fittings.

In the event of another national emergency, peacetime standards of supply will of necessity again be overhauled and streamlined. The ability to effect prompt repair will be limited by time and availability. In this situation, the reusability concept in hose and fittings will again assist in reducing the number of grounded aircraft and missiles, thus having the effect of multiplying the number of operational units at any given moment.

**Specify Aeroquip Patented\*  
"super gem" Reusable Fittings  
and Aeroquip Hose of Teflon.**

Aeroquip

AEROQUIP CORPORATION, JACKSON, MICHIGAN

AEROQUIP CORPORATION, WESTERN DIVISION, BURBANK, CALIFORNIA

AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO

Teflon is DuPont's trade name for its tetrafluoroethylene resin. "**super gem**" is an Aeroquip trademark. \*U.S. Patent Nos. 2,833,567 and 2,731,279

Write in No. 157 on Reader Service Card at start of Product Preview Section



## THE HUMAN FACTOR in today's technology

Scientists have long been preoccupied with the technological problems of Man and the Machine. The increasingly complex nature of advanced systems has created an urgent need to enhance man's contribution to effective systems performance. The complicated nature of this relationship requires the skills of psychologists, social scientists, mathematicians, and engineers.

At Ramo-Wooldridge, human engineering, personnel selection, individual and system training, display design, and communications are successfully integrated into systems design and development by the technique of large-scale simulation.

Simulated inputs enable scientists to observe a system as it operates in a controlled environment and make possible the collection of data on performance, training, human engineering, maintenance, and logistics and support. Scientists and engineers use this data to assure the design, production, and delivery of a unified system capable of high performance and reliability.

Expanding programs at Ramo-Wooldridge in the broad areas of electronic systems technology, computers, and data processing have created outstanding opportunities for scientists and engineers. *For further information concerning these opportunities write to Mr. D. L. Pyke.*



**RAMO-WOOLDRIDGE**  
P. O. BOX 90534, AIRPORT STATION • LOS ANGELES 45, CALIFORNIA  
a division of **Thompson Ramo Wooldridge Inc.**

Check Employment Inquiry Form on Page 233

SPACE/AERONAUTICS

October 1959

good until 12/15/59

**Employment Inquiry Form**

(NOT an application for employment)

**THIS INQUIRY FORM** is a service that makes it easier for the interested reader to explore employment opportunities with organizations featuring recruitments advertising in this issue.

To use this Form, follow these simple steps:

- (1) Tear out this page.
- (2) Check off the organization(s) listed below whose employment offers are of interest to you. Use typewriter or pencil.
- (3) Turn to the back page of this Form and answer the questions on it.
- (4) Mail this form (in a stamped envelope) to:

Reader-Service Dept.

**SPACE/AERONAUTICS**

205 East 42nd St.

New York 17, N.Y.

We will do the rest and promptly forward a copy of your Inquiry Form to each of the organizations you have checked. Depending on their specific personnel requirements, they will get in touch with you at your home.

I am interested in the employment opportunities at:

<input type="checkbox"/> AC Spark Plug—The Electronics Div. of General Motors	255	United Aircraft Corp.	236
<input type="checkbox"/> Aeronutronic Systems, Inc., A Subsid. of Ford Motor Co.	244	<input type="checkbox"/> Motorola Communications & Electronics, Inc.	99, 100, 101
<input type="checkbox"/> AiResearch Corp.	246, 356	<input type="checkbox"/> Norden Labs.; United Aircraft Corp.	242
<input type="checkbox"/> Autonetics Div.; North American Aviation	85, 242, 318	North American Aviation	
<input type="checkbox"/> Bendix Aviation Corp.; Bendix-Pacific Div.	246	<input type="checkbox"/> Autonetics Div.	85, 242, 318
<input type="checkbox"/> Convair; Astronautics Engineering Div.	262	<input type="checkbox"/> Los Angeles Div.	268, 282, 302
<input type="checkbox"/> Garrett Corp.	246, 356	<input type="checkbox"/> Rocketdyne Div.	244
General Electric Co.		<input type="checkbox"/> Pan American Airways, Inc.; Guided Missiles Range Div.	98
<input type="checkbox"/> Heavy Military Electronics Dept.	235	<input type="checkbox"/> Ramo Wooldridge; A Subsid. of Thompson-Ramo-Wooldridge, Inc.	232
<input type="checkbox"/> Light Military Electronics Dept.	245	<input type="checkbox"/> Republic Aviation Corp.	243
<input type="checkbox"/> Small Aircraft Engines Dept.	238	<input type="checkbox"/> Rocketdyne Div.; North American Aviation	244
<input type="checkbox"/> General Motors Corp.; AC Spark Plug Electronics Div.	255	<input type="checkbox"/> Rohr Aircraft Corp.	240
<input type="checkbox"/> Guided Missiles Range Div.; Pan Am Airways, Inc.	98	<input type="checkbox"/> Solar Aircraft Co.	238
<input type="checkbox"/> Jet Propulsion Labs.; Calif. Inst. of Tech.	291	<input type="checkbox"/> Space Technology Lab.	27
<input type="checkbox"/> Lockheed Aircraft Corp.	305	<input type="checkbox"/> Systems Development Corp.	237
<input type="checkbox"/> Los Angeles Div.; North American Aviation	268, 282, 302	<input type="checkbox"/> Texas Instruments, Inc.	239
<input type="checkbox"/> Martin Co., The; Activation Div.	70, 71	<input type="checkbox"/> Thompson-Ramo-Wooldridge, Inc.; Ramo Wooldridge Div.	232
<input type="checkbox"/> Minneapolis-Honeywell Reg. Co.; Aeronautical Div.	240, 315	United Aircraft Corp.;	
<input type="checkbox"/> Missile & Space System Div.;		<input type="checkbox"/> Missile & Space System Div.	236
		<input type="checkbox"/> Norden Lab.	242
		<input type="checkbox"/> Westinghouse Electric Corp.; Baltimore Div.	241

OTHER (Some organizations' recruitment advertising in this issue may have arrived too late for inclusion in the above list. If you are interested in the employment offers of any of these organizations, just note its name and the page number of its advertisement in this space. Please refer only to ads keyed to this form.)

NOTE: If you have an immediate interest in any special employment opportunity advertised in this issue and would like to give more details about your qualifications than can be noted on this Form, we advise you to send your resume directly to the person or department given in the advertisement. We'd appreciate it if you'd mention SPACE/AERONAUTICS in your application.

October 1959

## Employment Inquiry Form

Please type or print (with pencil)

(NOT an application for employment)

**FIELDS OF INTEREST** (in order of importance, note the general fields in which you would like to work—e.g., basic research, dynamics, structures, rocket propulsion, electronic systems, pneumatics, testing, materials, production, ground support, etc.): \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**SPECIALIZED JOB EXPERIENCE** (describe the specific technical areas in which you have worked—e.g., flutter, fatigue, fuel systems, circuit miniaturization, servo systems, hydraulic pumps, tool engineering, orbit mechanics, telemetry, data processing, wind tunnel testing, etc.):  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**JOB'S AND EDUCATION**

List your last 3 employers:

EMPLOYER	CITY & STATE	YEARS EMPLOYED	JOB TITLE OR FUNCTION

List your college and university degrees:

SCHOOL	YEARS ATTENDED	DEGREE

Special Training \_\_\_\_\_

**PERSONAL DATA**AGE ..... U. S. CITIZEN  YES  NO If not, when do you expect to become a citizen? .....

Name: .....

Home Address: .....

Home Telephone: .....

Make sure you have checked the companies you are interested in on the other side of this Form. Then put the Form in a stamped envelope and mail it to Space/Aeronautics.

Check Employment Inquiry Form on Page 233 ➔

Since this ad  
first appeared on June 16<sup>th</sup> 1959  
43 engineers have joined HMED—and there  
are approx. 38 positions at all levels open now!



ENGINEERS • SCIENTISTS

General Electric's Heavy Military Electronics Dept.  
**AWARDED CONTRACT FOR**  
Systems Integration, Engineering, and Management of...  
**AIR WEAPONS CONTROL SYSTEM 212L**

A universal electronic control system to meet the vast problem of Air Defense outside of the Continental United States.

Systems-oriented engineers and scientists will appreciate the broadband technical challenge of the Air Weapons Control System 212L. There are important openings for men who are experienced in: WEAPONS SYSTEMS ANALYSIS • MATHEMATICAL ANALYSIS OF ENGINEERING PROBLEMS • COMPUTER PROGRAMMING • MILITARY COMMUNICATION SYSTEMS • RADAR SYSTEMS • WEAPONS CONTROL SYSTEMS • ELECTRONIC CIRCUITRY • INDUSTRIAL & MILITARY PSYCHOLOGY

- Working in close cooperation with the USAF, it is Heavy Military's responsibility to integrate all subsystems—data acquisition, communications, data processing and display—plus various defensive weapons into a well coordinated and efficient operating system.

**VERSATILE AIR CONTROL APPLICATIONS** The revolutionary 212L can be used to defend a single airfield, or, by linking control sites together, it could be used in a limited action to provide air control for an area the size of Alaska. Similarly, by linking the capabilities of countries together, a system could be provided for the air control of an en-

tire continent. Designed for both fixed and mobile applications, the 212L will be used primarily outside the U. S. since the SAGE system is used for the defense of this country.

**HMED IS ALSO DESIGNING THE "HEART" OF THE SYSTEM**

In addition to its prime mission of providing systems management, HMED will design, develop and produce the data processing and display subsystem which is the "heart" of the 212L. Capable of rapidly and automatically detecting and tracking air targets, the subsystem operates without human assistance, except under unusual circumstances.

**OTHER FAR-RANGING PROGRAMS AT HEAVY MILITARY**

At the present time additional far-ranging programs are being pursued in diverse and important areas at HMED:

- Fixed & Mobile Radar
- Shipborne Radar
- Underwater Detection Systems
- Missile Guidance
- Data Handling Systems
- Communications

Individuals with experience in systems analysis or specific equipment design in the areas listed above are invited to forward their resume in complete confidence to Mr. George Callender, Div. 60-MJ.

HEAVY MILITARY ELECTRONICS DEPARTMENT  
**GENERAL ELECTRIC**  
COURT STREET, SYRACUSE, N.Y.

Write today  
Call me  
collect at  
GR 6-4411,  
Ext. 1830  
George  
Callender

# Connecticut



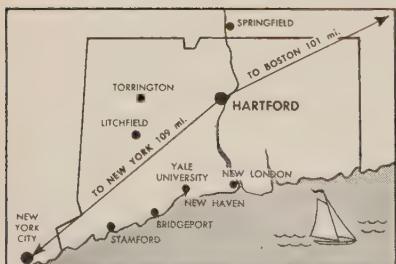
A PLACE TO *live* AS WELL AS WORK

Home shouldn't be simply a place to eat and sleep. It is the wellspring of your relaxing hours and the backdrop for your children's growth. Connecticut is a region rich in cultural and historical heritage...and abundant with recreational facilities. Picture a New England fall in

Connecticut...the trees ablaze with color, the sparkling days and cool nights...the nostalgic fragrance of burning leaves. Yes, it is a good place to live...particularly if you have invested your talents in a

## CAREER POSITION WITH MISSILES & SPACE SYSTEMS

United Aircraft Corporation's Newest Division



Positions offering unprecedented advancement opportunities in the field of Weapons Systems are open for qualified engineers and scientists with skills in

ELECTRONICS • ASTROPHYSICS • OPERATIONS RESEARCH  
MATHEMATICS WEAPONS RESEARCH • RECONNAISSANCE SYSTEMS  
TACTICAL WARFARE • WARNING SYSTEMS  
INTELLIGENCE SYSTEMS

Please reply to Mr. John North  
Engineering Department

MISSILES & SPACE SYSTEMS A Division of UNITED AIRCRAFT CORPORATION

436 Main Street, East Hartford, Connecticut

Check Employment Inquiry Form on Page 233

**A**T SOME POINT IN HIS CAREER, every engineer critically evaluates himself in terms of his professional growth and progress. If your evaluation indicates that you have developed a depth of appreciation for the major problem areas in large complex electronic systems and the technical competence to contribute to the solution of such problems, you should seriously consider the next step in your professional career and explore the challenging opportunities the System Development Corporation has to offer.

"SDC has assumed major responsibilities for development and sustaining engineering and the implementation of engineering advances in the state of the art associated with the SAGE Air Defense System, the world-wide SAC Control System, and other major system development projects. Therefore, at SDC engineering is system-oriented and requires personnel with broad backgrounds and extensive experience in design, development and system engineering.

"The experience gained through intimate association with all of the elements of these large-scale systems and subsystems they control provides a most unusual opportunity for engineers to grow in technical competence and professional stature.

"I invite you to explore the opportunities offered by SDC at Santa Monica, California and Lodi, New Jersey, by writing or telephoning Mr. R. A. Frank, 2424 Colorado Avenue, Santa Monica, California, EXbrook 3-9411, or Mr. R. L. Obrey, Box 2651, Grand Central Station, New York 17, N.Y., ELdorado 5-2686, regarding our division at Lodi, New Jersey. Your correspondence will receive preferential treatment and its content will be handled in strict confidence."



V.J. BRAUN, ASSISTANT DIRECTOR FOR PLANNING,  
ENGINEERING DIRECTORATE



V. J. BRAUN

## SYSTEM DEVELOPMENT CORPORATION



SANTA MONICA, CALIFORNIA • LODI, NEW JERSEY

Check Employment Inquiry Form on Page 233

# THREE HIGH LEVEL ENGINEERING POSITIONS in MISSILES & SYSTEMS

## CHIEF OF PRELIMINARY DESIGN

An advanced degree is desirable for this position. Applicant should have 10 years of successful experience in the design of missiles, related equipment, or major components and subsystems. He should have strong creative ability. From stated operational requirements, he should be able to evolve optimum configuration and performance details. These must integrate aerodynamic, structural, avionic and manufacturing requirements. Though he will be supported by specialized departments in these fields, he should be able to do preliminary analyses and to advise the specialists in their more detailed work. As a supervisor he will direct a small group of preliminary design specialists.

## CHIEF, ASTRO AERO SCIENCES

Prefer advanced degree plus ten years of experience in aircraft, missile, and space flight fields especially in the areas of flight mechanics, aerodynamics, thermodynamics, and celestial mechanics. Applicant should be extremely competent analytically, and also shall have had experience in personally conducting important technical investigations which are highly difficult and complex.

## CHIEF, AVIONICS

Prefer advanced degree plus ten years of experience in aircraft, missile, and space flight fields especially in the area of guidance, controls, and electronic systems. Applicant should be extremely competent analytically, and also shall have had experience in personally conducting important technical investigations which are highly difficult and complex.

## SOLAR SPECIFICS

These openings have resulted from Solar's rapidly expanding space-age R&D programs. Exciting current projects include an ARPA anti-missile defense system. Solar is a medium-size company (2500 people in San Diego) with a successful history since 1927. A new 60,000 sq. ft. engineering building will be completed this year. In addition to greater career opportunities, Solar offers you the advantages of living in sunny San Diego, California—with the best year-around climate in America and excellent cultural, educational and recreational facilities.

**SEND RESUME.** Please send resume of your qualifications at the earliest opportunity to Louis Klein, Dept. E-433, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.



Check Employment Inquiry Form on Page 233

"A chance to  
inject your ideas  
and personality  
into something  
that works."

## ENGINE DEVELOPMENT

Must have a sound knowledge of mechanical and thermodynamic or controls design for development of small engines being used in highly advanced aircraft such as supersonic fighters, high speed transports and helicopters.

Direct engine development through design studies and test programs including flight test.

Determine and evaluate engine performance characteristics and initiate design improvements.

## ENGINE MECHANICAL DESIGN

Must have experience in designing and developing machine components. Working in a free atmosphere, you will be responsible for creative and analytical design of turbo-engine components. With laboratory, production, and evaluation liaison, you will have opportunity to follow your design through manufacturing and development stages to flight qualifications.

Reply in complete  
confidence to:

Mr. Richard A. Hollenberg  
Professional Recruiting  
and Placement

## SMALL AIRCRAFT ENGINE DEPARTMENT

1174 Western Ave.  
West Lynn, Mass.

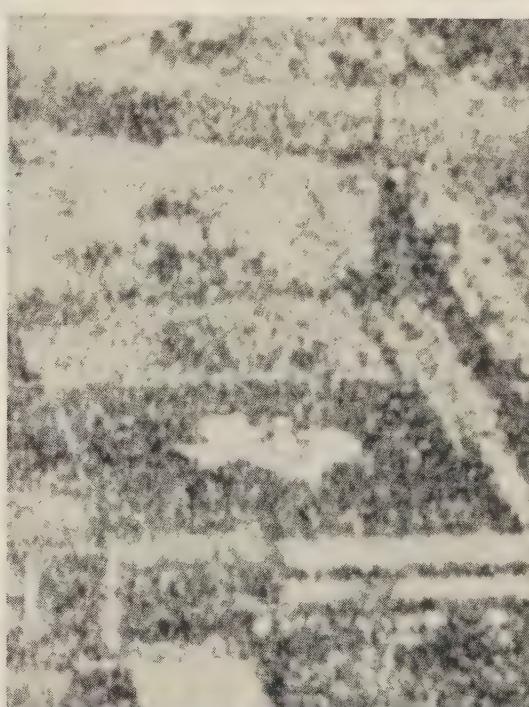
GENERAL  ELECTRIC

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Check Employment Inquiry Form on Page 233 →

# IDEA



ORIGINAL PHOTO



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BY QUANTIZING AND CODING

design, manufacturing and quality control engineers — 3-10 years experience

## Careers and ideas at TI

as come where they are encouraged, and at TI's Apparatus Division engineers work in a permissive atmosphere, one which produces creativity as a natural result. Both the modern air-conditioned work facilities and the pattern of life in the progressive city of Dallas encourage a man to his most efficient productivity and rewarding accomplishments.

Our experience in one of the following technologies may find immediate application in our Electronic Surveillance, Antisubmarine Warfare, Heavy Surface Radar, or Missile Systems programs.

• sonar • infrared • magnetic anomaly detection • passive detectors • servos • navigational systems • special-purpose computers • timers • programmers • microwave • telemetering data link • optics • video mappers • visual displays • intercom

Our stable growth requires a steady influx of men qualified in these technologies. To learn more about us and how we can fit into your career plan, write for a copy of "We can tell you this much about Apparatus division" to: **J. R. Pinkston, Department 103 Apparatus Division**

### current career openings

**EE's & PHYSICISTS:** missile guidance, control systems design and analysis, radar (ground and airborne), antenna and microwave components, servo-mechanisms, telemetry, digital circuits, sonar, infrared design, and flight test.

**ME's:** antenna, mechanisms, miniaturization, thermodynamics, refrigeration, insulation, packaging, and structures design.

**INDUSTRIAL ENGINEERS:** cost estimating, quality control, and quality assurance studies.

**MANUFACTURING ENGINEERS:** tooling design and production planning and supervision. (Degrees in EE or ME.)

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RELOCATION

APPARATUS  
DIVISION

TEXAS INSTRUMENTS INCORPORATED

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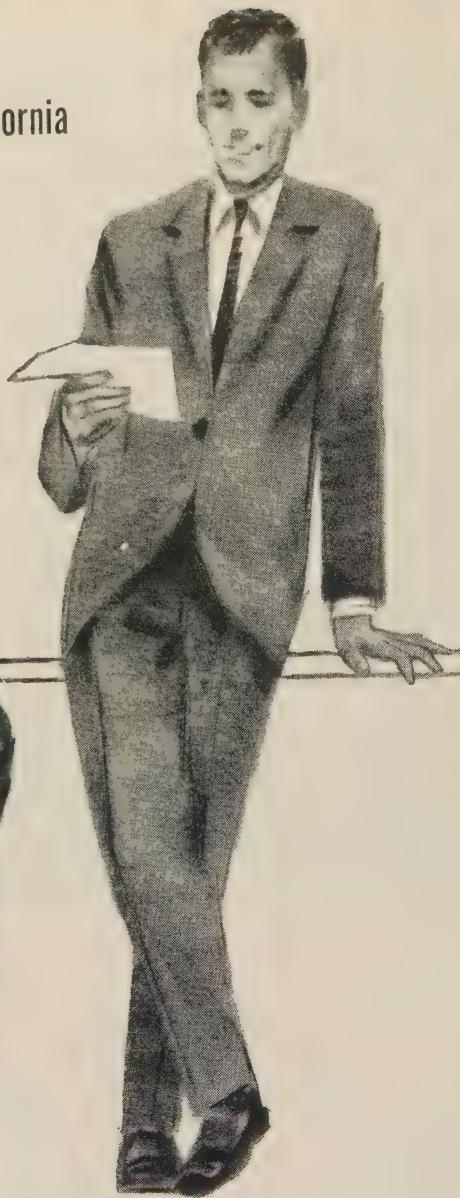
DALLAS 9, TEXAS

# TO ENGINEERS

who desire to build a future  
in fast-growing Southern California

## Rohr Interviews in October

in the cities shown below



Professional opportunities in Southern California for engineers in these fields: Structures, Design, Welding, Bonded Structures, Liaison, Industrial. Men from Rohr will soon be conducting personal interviews in the following cities:

Akron  
Baltimore  
Buffalo

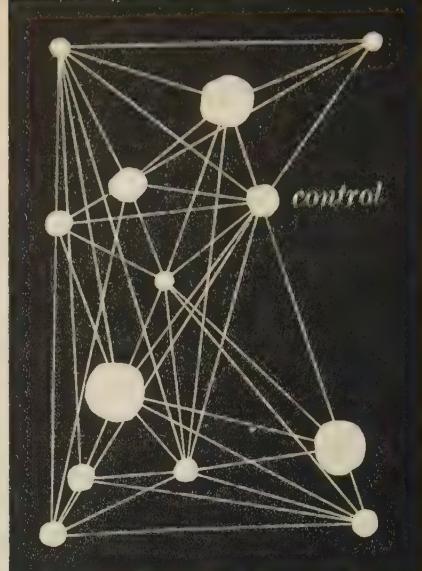
Chicago  
Cincinnati  
Dallas

New York  
Philadelphia  
St. Louis

Detailed resumes from qualified applicants will be held in confidence and given prompt attention in the arrangement of local interviews. Address J. L. Hobel, Industrial Relations Manager, SA-3 Rohr Aircraft Corporation, Chula Vista, California.

SA-1

Check Employment Inquiry Form on Page 233



## *careers in control of space*

For 74 years, Minneapolis Honeywell has pioneered and led the development and production of advanced automatic controls. Today, with work in this area more demanding and more rewarding, new opportunities exist for engineers.

**PRODUCTION:** Develop and establish assembly processes for a wide range of products. Requires background in complex devices such as gyro's, accelerometers, flight systems, and a thorough knowledge of production processes.

**EVALUATION:** Test engineer interested in career in development, qualification, reliability testing. Must be graduate engineer with electronic background.

**ADVANCED GYRO DESIGN:** Engineers with two and up to twenty years' experience in such areas as precision gyro mechanics, servo techniques, digital data handling, electronics packaging, advanced instrumentation and magnetic components design.

**FLIGHT CONTROL SYSTEMS:** Analytical, systems, component engineers to design and develop advanced flight reference and guidance systems. Prefer airborne systems or servo experience.

**FIELD SERVICE:** Monitor airborne system performance in U.S. and overseas. Conduct training, liaison with military, BSEE preferred, or graduate engineer with high electronic aptitude.

**GROUND SUPPORT:** Senior engineers with logical design experience and engineers with experience in ground support or related areas. Outstanding growth opportunity in new division.

If you're interested in a challenging career in advanced automatic controls, write Mr. Bruce D. Wood, Technical Director, Dept. 847D.



**Honeywell**   
AERONAUTICAL DIVISION  
1433 Stinson Blvd., N.E., Minneapolis 13, Minn.  
To explore professional opportunities in other Honeywell operations coast to coast, send your application in confidence to H. D. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

Check Employment Inquiry Form on Page 233  
SPACE/AERONAUTICS



## The Modern Merlin

The legendary Merlin's wizardry would have been no match for the problems facing today's engineers. At Westinghouse-Baltimore, for instance, engineers are devising a stratospheric disappearing act at 2000 mph. This feat of electronic legerdemain involves an electronic defense system to shield a manned aircraft from the prying eyes of enemy intelligence. In their bag of tricks, Westinghouse engineers have electro-magnetic techniques and other advanced technical developments that will significantly increase the manned aircraft's capacity for self defense.

This program, including advanced development and design work on airborne electronic counter-measures,

is one of several current projects offering stimulating career opportunities for engineers in the following fields:

### Airborne Electronic Counter-Measures

Systems Engineers	Digital Computer Design
Broad Band Amplifiers	Microwave Systems & Components
Signal Analysis	Antenna Design

### Radar Systems

Infrared Systems Development	
Solid-State Devices & Systems	
Automatic Check-Out & Fault Isolation	
Ferret Reconnaissance	
Electronics Instructors	
Communications Circuitry	
Field Engineering	
Technical Writing	
Electronic Packaging	

FOR DETAILS . . . and a copy of the informative brochure "New Dimensions," send a resume of your education and experience to: Mr. A. M. Johnston, Dept. 971, Westinghouse Electric Corporation, P.O. Box 746, Baltimore 3, Maryland

**Westinghouse**  
**BALTIMORE**

Check Employment Inquiry Form on Page 233

Engineers

# At Norden Laboratories... there's more than talk about Advanced Programs, there are challenging complex problems being solved regularly...

OUR WIDELY diversified programs in advanced areas require men with solid engineering backgrounds who by employing a sound business approach, can get a job done. Norden is an "engineers' company." Here you can work with modern equipment on many important projects. You will be associated with top men in the precision electronics field and have available a strong force of support personnel. Norden's management knows and appreciates good engineering and understands the problems engineers face working in complex areas.

*There are career openings at two fine locations — White Plains, New York and Stamford, Connecticut — for capable, creative men at all levels of experience:*

**Section Heads**

MICROWAVE & ANTENNA  
AIRBORNE RADAR RECEIVER  
SONAR DEVELOPMENT

**Project Engineers**

INERTIAL PLATFORMS  
MILITARY TELEVISION  
GROUND SUPPORT & TEST EQUIPMENT  
RADAR & INDICATOR DISPLAYS

**Systems Engineers**

RADAR & TELEVISION  
FIRE CONTROL • NAVIGATION  
SYNTHESIS & ANALYSIS  
GUIDANCE & CONTROL  
ASW SYSTEMS • SERVO ANALYSIS

**Circuit Development Engineers**

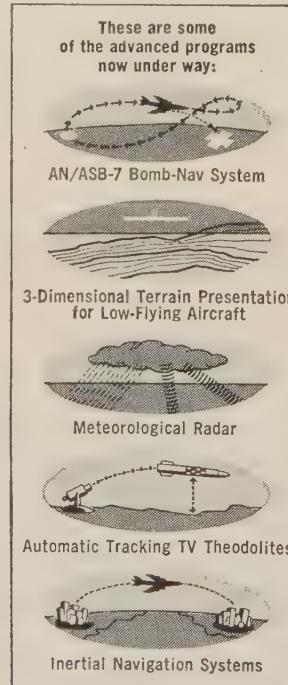
VIDEO & CRT DISPLAYS  
RADAR TRANSMITTERS AND RECEIVERS  
TRANSISTOR PULSE CIRCUITRY

**Equipment Design Engineers**

MISSILE & AIRBORNE TELEVISION  
AIRBORNE RADAR & FIRE CONTROL  
ADVANCED PRINTED CIRCUITS  
MICROMINIATURE ELECTRONICS

**Quality Assurance Engineers**

RELIABILITY • STANDARDS  
ENVIRONMENTAL TEST  
COMPONENT EVALUATION

**► SATURDAY & EVENING INTERVIEWS ARRANGED ◀**

Send resume to:

Technical Employment Manager

**NORDEN LABORATORIES**

NORDEN DIVISION OF UNITED AIRCRAFT CORPORATION  
121 Westmoreland Avenue — White Plains, New York

Within driving distance of entire New York—New Jersey Metropolitan area  
White Plains, New York Stamford, Connecticut

Check Employment Inquiry Form on Page 233

ELECTRONICS: Over, on and under...



Electronic and  
Electromechanical  
**SYSTEMS ENGINEERS**

Openings are waiting for you at  
Autonetics

in

Systems Research and  
Development

on

Integrated Systems involving  
the following equipments:

**Radars****Inertial Guidance****Digital Computers****Flight Control Equipment**

Opportunities have never been better in the history of Autonetics for the engineer with sound technical competence in the above fields.

Advanced degrees preferred, with four to ten years' broad experience in the above or related fields.

Send your resume to:

Mr. B. D. Benning  
Manager, Employment Services  
Dept. D-106  
9150 East Imperial Highway  
Downey, California

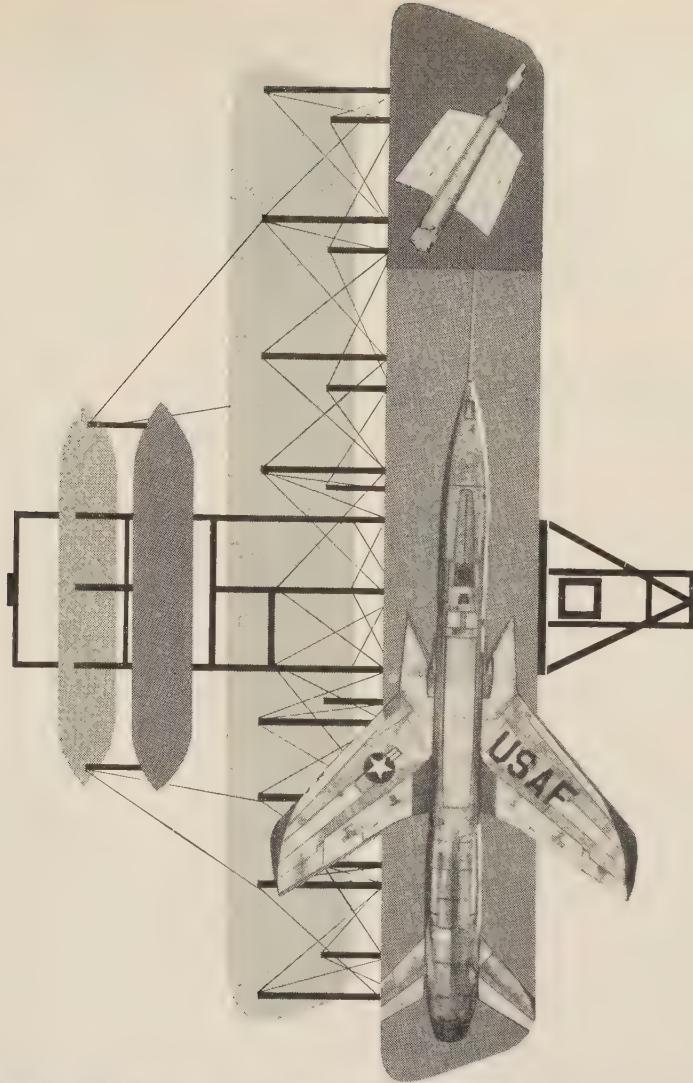
**Autonetics**

A Division of North American Aviation, Inc.



Check Employment Inquiry Form on Page 233

SPACE/AERONAUTICS



# IDEAS CLEARLY IMAGINED BECOME REALITIES AT REPUBLIC AVIATION

During the early years of this century the airplane was only the dream of a few dedicated men. Yet in the short span of 5 decades this dream has evolved into such advanced aircraft as Republic's F-105 — the free world's most powerful fighter-bomber — which is capable of flight in the Mach 2 regime.

The same holds true for missiles and space vehicles. Thirty brief years ago they existed in only a few imaginations. Today at Republic the imaginations of many men are working to create the vehicles that will allow man to explore the last frontier — space. Included in this far-ranging research and development effort are plasma propulsion systems, electronic and hydraulic subsystems that will operate efficiently in extreme environments, and the calculation of super-accurate space flight trajectories.

Working across the total technology of flight, Republic engineers and scientists see their ideas become realities because the novel, the unique and the revolutionary in technical thinking are appreciated and encouraged by management. New investigations and new contracts mean you can put your ideas in motion at Republic Aviation.

**Immediate Openings in Advanced Areas for Engineers and Scientists at all Levels of Experience:**

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**PLASMA PROPULSION:** Plasma Physics • Gaseous Electronics • Hypersonics and Shock Phenomena • Hydromagnetics • Physical Chemistry • Combustion and Detonation • Instrumentation • High Power Pulse Electronics

**NUCLEAR PROPULSION & RADIATION PHENOMENA:** Nuclear Weapons Effects • Radiation Environment in Space • Nuclear Power & Propulsion Applications • Nuclear Radiation Laboratories

*Send resume in confidence to:*

*Mr. George R. Hickman*

*Engineering Employment Manager, Dept. 6K*



**REPUBLIC AVIATION**  
FARMINGDALE, LONG ISLAND, NEW YORK

Check Employment Inquiry Form on Page 233

# CONTROL ENGINEERS

(Electric • Servo • Valves)

**Move into Large Rocket Engineering  
and put yourself way ahead in your field**

Help us to automate millions of horsepower designed into a jet-size package—the High-Thrust Rocket Engine. Here are the fields:

*The Electrical System* includes Ground Support and Checkout Equipment which must be operable by military personnel. Aboard the missile, engine controls must be carefully isolated from other missile systems. Miniaturization is striven for, but never at the expense of reliability in extremes of temperature, vibration and acceleration. You'll cover all aspects of circuitry, deal with every branch of weapons systems.

*Servo-mechanisms* offer a broad spectrum—electronic, pneumatic, mechanical, hydraulic. Your analytical ability will be at a premium here, to evaluate methods of Mixture Control, Thrust Control, and Pressure Control which must compensate for variables like changing mass, drag lapse-rate, altered combustion efficiency, heat, cold, G, vibration etc. You'll be free of routine details, able to apply your training and experience toward a high level of professional growth.

*Valves* run to 6" diam. and up, with very high pressures and flow rates, extremely rapid action, temperatures down to -300°F.

This is where the real advanced work in controls is being done. Join the trailblazers. Write, giving your background: Mr. F. K. Jamieson, Rocketdyne Engineering Personnel, 6633 Canoga Avenue, Canoga Park, California.

**ROCKETDYNE**   
A DIVISION OF NORTH AMERICAN AVIATION, INC.

BUILDERS OF POWER FOR OUTER SPACE

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## RESEARCH OPPORTUNITIES

in

# SPACE SCIENCES

The Space Technology Operations of Aeronutronic has immediate need for engineers and scientists who are interested in working in the stimulating and highly diversified field of space sciences. This West Coast division of Ford Motor Company has the newest facilities and most advanced equipment for carrying out highly technical work — challenging creative work that is exceptionally rewarding to qualified men.

Positions are at Aeronutronic's new \$22 million Research Center, being completed at Newport Beach, Southern California. Here, overlooking famous Newport Harbor and the Pacific Ocean, relaxed California living can be enjoyed free of big-city congestion, yet most of the important cultural and educational centers are just a short drive away.

## AREAS OF INTEREST

### VEHICLE TECHNOLOGY

Aerodynamic design and testing  
Rocket Nozzle and re-entry materials  
High temperature chemical kinetics  
Combustion thermodynamics  
High temperature structural plastics and ceramics  
Advanced structures

### SYSTEMS DEVELOPMENT

Aerothermodynamics  
Re-entry programs  
High temperature heat transfer  
Penetration systems  
Hyper environmental test systems

### ELECTRONICS AND ASTRO SCIENCES

Astro navigation  
Space communications and communication satellites  
Instrumentation, telemetering and data reduction  
Space environmental physics  
Advanced techniques and system studies

Qualified applicants are invited to send resumes and inquiries to Mr. R. W. Speich, Aeronutronic, Dept. 11, Box 451, Newport Beach, California.

## AERONUTRONIC

a Division of Ford Motor Company  
Newport Beach  
Santa Ana • Maywood, California

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SPACE/AERONAUTICS

# Thinking of changing your job someday?

Here are 14 Reasons  
to Consider  
**GENERAL ELECTRIC'S**  
**LIGHT MILITARY**  
**ELECTRONICS DEPARTMENT**  
NOW...



**Top Salaries**, fully competitive with compensation throughout the industry, with increases based on actual performance, not seniority.



**Desirable Assignments** to match your electronics specialty in any one of 30 expanding groups; activities range across the spectrum from audio to infrared. Specific programs include a revolutionary Bomb Nav, Radar System, Polaris Fire Control and Guidance Computer, Sidewinder Guidance, Satellite Communications, Advanced Airborne Detection/Data Processing/Command System, and Missile Fuzing, to name a few.



**Promotional Opportunities** provided by Light Military's fast growing programs, as evidenced by the fact that engineering staff and support personnel have grown from 160 in 1952 to 1469 this year.



**Career Stability** assured by diversification which enables Light Military's expansion to be independent of any individual military program.



**Graduate Study Plan** that covers the cost of tuition, textbooks and transportation to and from graduate school.



**An Opportunity to Consult** with top scientists in G-E laboratories and gain access to the newest technical concepts.



**In-Plant Courses** provide broad coverage in technical and managerial subjects — are open to all professional personnel.



**Professional Stature** is enhanced by project diversity that offers ample opportunity to develop competence in related disciplines and product areas.



**Comprehensive Orientation Program** assists new professional personnel in feeling "at home" immediately.



**G.E.'s Famous Benefit Program** that includes comprehensive insurance and the valuable savings and security plan.



**Vacationland Living** in beautiful, upstate New York where year round recreation is close to your door.



**No Long Commuting** 90% of LMED's personnel live within 15 minutes of work.



BENDIX-PACIFIC NEEDS SYSTEMS  
AND CIRCUIT DESIGNERS FOR

# advanced submarine detection systems

## Unusual Creative Opportunities for

- Electronic engineers with a well rounded background to participate in a unique research and development program.
- Qualified mechanical design engineers including structural thermo-dynamicists in this challenging new field.

**Bendix-Pacific**

DIVISION OF BENDIX AVIATION CORPORATION

NORTH HOLLYWOOD, CALIFORNIA

SEND RESUME OF YOUR QUALIFICATIONS TO MR. WALKER AT

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## GROW WITH AIRESEARCH IN ELECTRONICS

**A**iResearch expansion in electronics and electromechanical activity is creating outstanding positions at all levels for qualified engineers.

### CONTROLS ANALYSIS

Work in preliminary design stage involves servomechanisms analysis and analog computer techniques.

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*Send resume to: Mr. Robert Richardson*



AiResearch Manufacturing Division

9851 So. Sepulveda Blvd., Los Angeles 45, Calif.

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## Investigating Employment Opportunities?

Want more information about employment opportunities offered by companies advertising in this issue? Then be sure to give complete data about your job interests, experience and education when filling in the "Employment Inquiry" form.

Although not an application for employment, it provides employment managers with information to evaluate your capabilities—and in turn gives your request immediate consideration.

Check the "Employment Inquiry" form for details.



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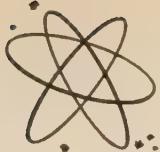
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2. Fill out your Name, Title, Company, Address and check industry activity.

3. Tear out and mail . . . no postage necessary. SPACE/AERONAUTICS' Reader Service Department will contact the manufacturer for you.



## product index to advertising

**T**HIS IS A SPECIAL REFERENCE to the product information given in the advertisements in this issue. It is intended solely to help the reader make the best use of these ads. Therefore the index does not necessarily cover all the products made by each advertiser. Also, cross-listings are not intended to exhaustively describe each product but merely to make sure that each product can be found with reasonable ease by the reader looking for it.

Similar indexes to services and employment opportunities featured in ads follow this index.

Advertisements for which complete proofs were not available to the Editorial Department by the closing date are not necessarily covered by these indexes. (Proofs can be forwarded internally by the Production Department only for advertisements meeting the closing dates.)

For more detailed information on any product or service advertised in this issue or featured in its Product and Data Reviews, use the handy Reader Service Card.

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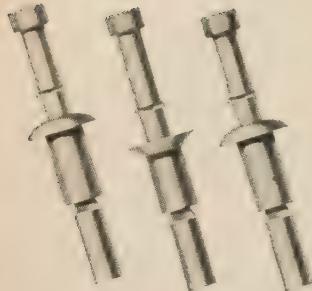
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# Five reasons why Cherry “700” rivets\* give you superior fastening



1. The “700” rivet design produces sheet clamping action that is superior to any other blind rivet. This same clamping action guarantees consistent uniform head seating.

2. Cherry “700” rivets provide a positive hole fill, even in oversized holes. Simplifies hole preparation problems in the shop and reduces hole drilling costs.

3. Wide grip range. One rivet can be used for several material thicknesses, thus reducing stock and lowering costs.

4. When installed, the wire-drawn portion of the stem, as shown, indicates that (1) a blind head has been formed, (2) the sheets have been clamped together, and (3) the rivet has expanded to fill hole.

5. High uniform stem retention is maintained within a greater hole tolerance range because the stem always adjusts to fill the hole.

Let us demonstrate the superior features of the Cherry “700” rivet in your shop on your trouble spots. Call or write Townsend Company, Cherry Rivet Division, P. O. Box 2157-H, Santa Ana, Cal.

\*Patents issued and pending

## CHERRY RIVET DIVISION

SANTA ANA, CALIFORNIA

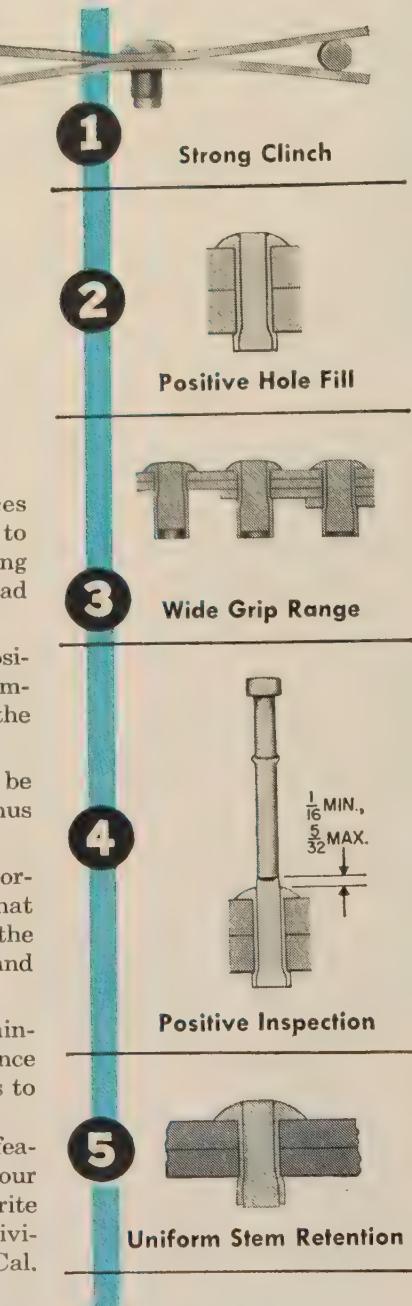
## Townsend Company

ESTABLISHED 1816 • NEW BRIGHTON, PA.

In Canada: Parmenter & Bulloch Manufacturing Company, Limited, Gananoque, Ontario

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SPACE/AERONAUTICS

*Automotive Power Steering Manufacturer Specifies*

# OSTUCO Mechanical Seamless Tubing

FOR  
SURFACE FINISH

Cold drawing Ostuco tubing through precision ring die on cold draw bench at Shelby mill. Mandrel controls and sizes I.D.

Automotive components are our business. We have produced literally millions. And we're still learning every day.

"One of the lessons we learned early in the game is that you can't beat Ostuco tubing for surface finish. It cuts our machining costs, keeps us on top competitively.

"There are other reasons, too, why Ostuco tubing tops our preferred list. We like its consistently close tolerances and unvarying quality, shipment after shipment. You might say we like its *product integrity* . . ."

To learn more about what Ostuco tubing can do for *your* production, contact your Ohio Seamless representative, listed in the Yellow Pages, or the mill at *Shelby, Ohio — Birthplace of the Seamless Steel Tube Industry in America*.

AA-9431

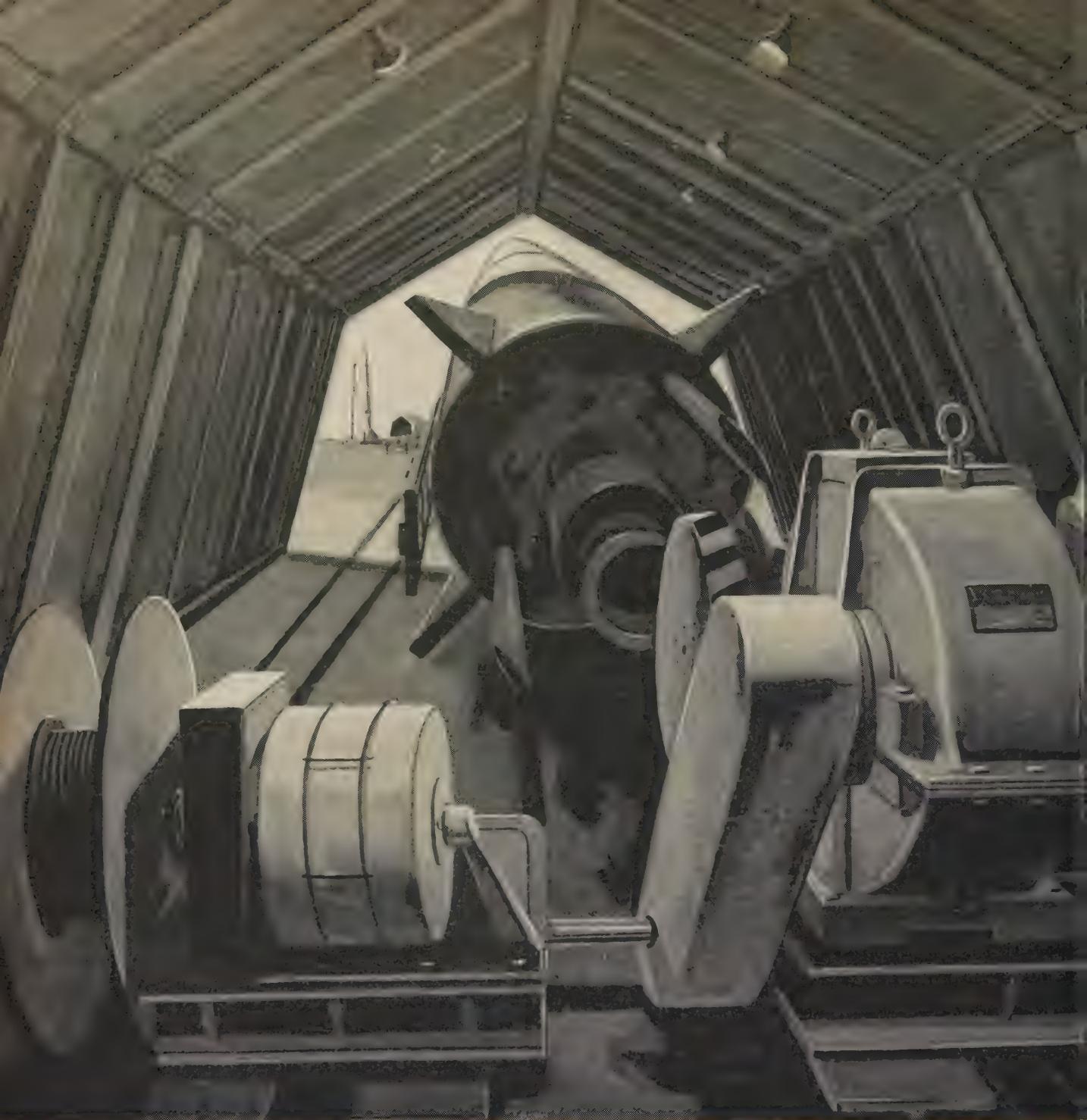


**OHIO SEAMLESS TUBE DIVISION**  
*of Copperweld Steel Company • SHELBY, OHIO*

*Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging*

**SALES OFFICES:** Birmingham, Charlotte, Chicago (Oak Park), Cleveland, Dayton, Denver, Detroit (Huntington Woods), Houston, Los Angeles (Lynwood), Miami, Moline, New Orleans (Chalmette), New York, North Kansas City, Philadelphia (Wynnewood), Pittsburgh, Rochester, St. Louis, St. Paul, Salt Lake City, Seattle, Tulsa, Wichita    **CANADA:** Railway & Power Engr. Corp., Ltd.    **EXPORT:** Copperweld Steel International Company, 225 Broadway, New York 7, New York

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## Westinghouse equipment drives

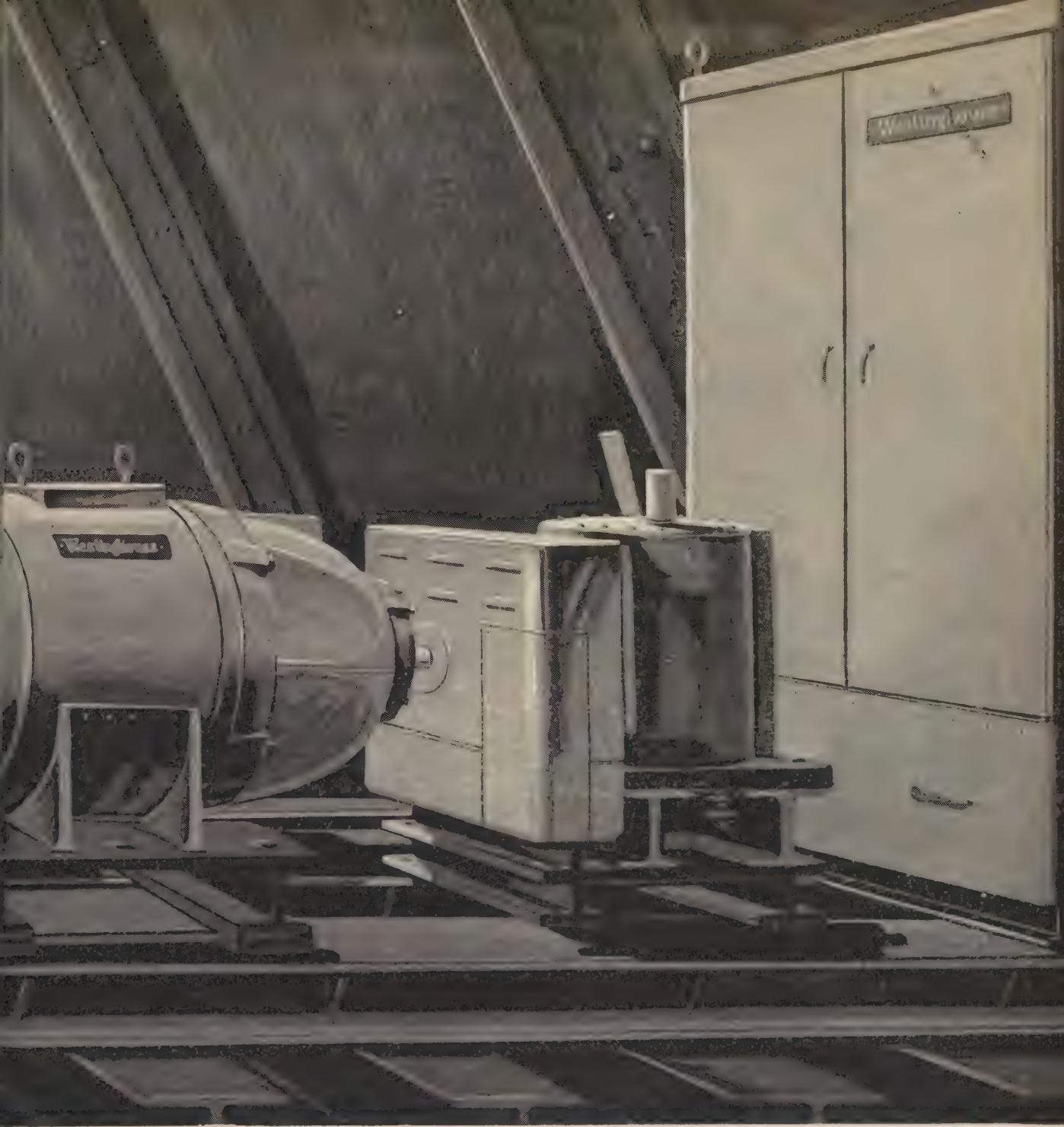
How do you move a 30-ton building at a uniform speed regardless of 60 mile an hour winds that might push with or against it? Westinghouse engineers solved this problem when they designed the automatic shelter drive system for the Douglas/USAF THOR IRBM.

Here is the installation—a fool-proof, self-controlled drive system. The operator pushes the forward or reverse button—the system does the rest, quickly—surely. Westinghouse React-O-Verse control automatically compensates for wind pressures to determine the instantaneous power requirement to move the huge shelter smoothly and uniformly, regardless of wind direction or force.

This is additional proof of the results you obtain when you use Westinghouse range of products, engineering knowledge, single-source responsibility and ability to supply a packaged, guaranteed unit.

Take advantage of these Westinghouse facilities when designing and building retractable shelters, hardened missile sites, erectors, lowering devices or launch pads. Contact your local Westinghouse sales engineer or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania.

An illustration of a hardened missile site, suitable for framing, will be sent you if requested on your letterhead.



J-92030

## THOR retractable shelters

The Westinghouse equipment includes: 75-hp crane and hoist; d-c magnetic brake; double reduction gear and flywheel unit; React-O-Verso control; pilot generator; manual and automatic switch and controls; and floodlighting.

YOU CAN BE SURE...IF IT'S  
**Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS"  
CBS-TV FRIDAYS



Typical THOR installation, showing a breakaway view of the drive unit in the retractable shelter, missile, free standing end wall of shelter and missile erector.

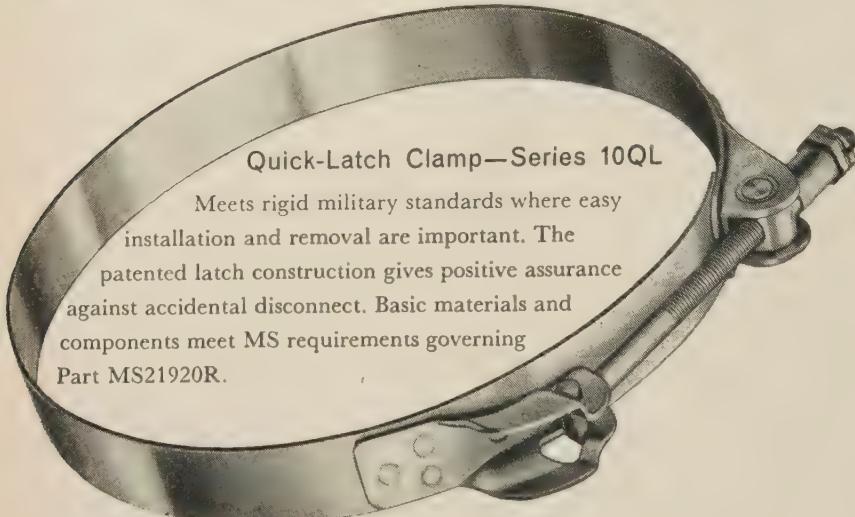
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# CLAMPS by WITTEK

## for the Space-Age

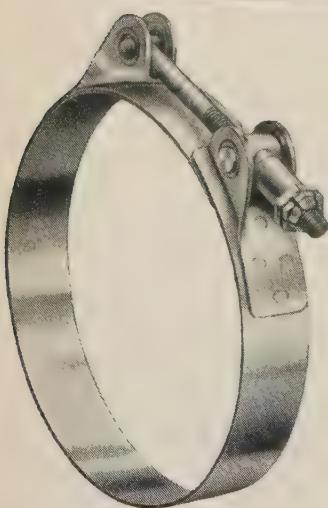
### STAINLESS STEEL FLAT BAND CLAMPS

Complete range of sizes from 2 1/4" to 10" diameter



#### Quick-Latch Clamp—Series 10QL

Meets rigid military standards where easy installation and removal are important. The patented latch construction gives positive assurance against accidental disconnect. Basic materials and components meet MS requirements governing Part MS21920R.



#### T-Bolt Clamp—Series 10T

Same as 10QL but without patented quick-latch, and recommended for more permanent applications. Meets MS requirements governing Part MS21920.

### STAINLESS STEEL AIRCRAFT CLAMPS

Complete range of sizes



Type AN737-TW  
(with shoe)



Type AN737-TWLS  
(without shoe)



Type AN737-RM  
(floating bridge)

Descriptive literature or recommendations for any clamping requirements upon request.

*Quality Clamps for over a Quarter Century*

**WITTEK MANUFACTURING CO.**

4368 West 24th Place, Chicago 23, Illinois

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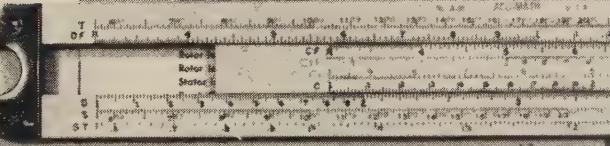
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#### NOMINAL ELECTRICAL DATA AT 25°C

Volts	10.2 volts
Excitation Current	.25 milliamperes
Power	.19 watts
Frequency	400 cps
Transformation Ratio (Max. Coupling)	2.203
Null Voltage	20 mv
Sensitivity	393 volts/degree



\*Other accuracies are available within the same envelope.

Worcester • Montgomery County • Pennsylvania



#### control transformer

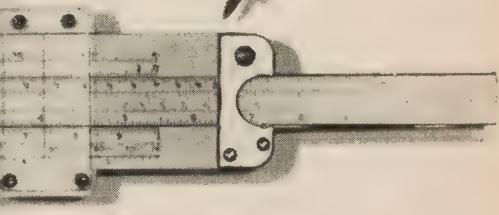
A cylindrical single phase rotor is inductively coupled to a stator with a symmetrical 3 phase Y-connected winding. The Control Transformer provides an electrical signal proportional to the angular difference between the rotors of the Transformer and Transmitter.

#### bearings

Stainless steel instrument ball bearings are used throughout. Standard lubricant is Warner Oil in accordance with MIL-L-4685A.

#### laminations

Coated laminations are used throughout.



## size 8 synchro data

Synchro data for the asking! Daystrom Transicoil has prepared comprehensive data sheets on its popular Size 8 Synchro Line. All the synchro information you need is clearly presented . . . with photos, detailed drawings, electrical characteristics, mechanical specifications, and electrical diagrams.

Data Sheets cover transmitters, control transformers, differentials, repeaters, resolvers, and inductive potentiometers. All units are corrosion resistant construction throughout. Accuracies to  $\pm 5'$  are available on special order. Write for your free set of Size 8 Data Sheets. Technical information on our Size 11 line is also available. Daystrom Transicoil, Division of Daystrom, Inc., Worcester, Montgomery County, Pa. Phone JUNO 4-2421. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Foreign: Daystrom International Div., 100 Empire St., Newark 12, N. J.



**DAYSTROM TRANSICOIL**

DIVISION OF DAYSTROM, INC.

Representatives in Canada and Other Foreign Countries

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# POWER FOR GROUND SUPPORT

### POWER GENERATION

As a component in ground support power supply equipment, the permanent magnet alternator assures exceptional reliability, high efficiency, high speed and maintenance free operation. A broad range of output ratings is available.

Using a permanent magnet alternator—mobile or portable ZEUS Engine Generator units offer a-c power... any place...any time. Wide range of output ratings.

### POWER INVERSION

Static and Rotary Inverters for dependable d-c to a-c power supplies. Design flexibility permits a series of models adaptable to the most exacting requirements.

### POWER CONVERSION

Efficient power conversion using existing PESCO designed and built precision motor-generator equipment or static power supplies for all ground power requirements.

**WRITE FOR COMPLETE DATA** on Permanent Magnet Alternators and Inverters or Static Inverters and Power Supplies.



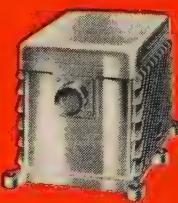
WESTERN BRANCH  
**PESCO PRODUCTS DIVISION**  
Borg-Warner Corporation  
3310 Vanowen Street, Burbank, California



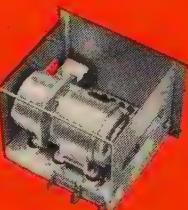
PERMANENT MAGNET ALTERNATOR



ZEUS ENGINE GENERATOR



STATIC INVERTER



MOTOR-GENERATOR SET

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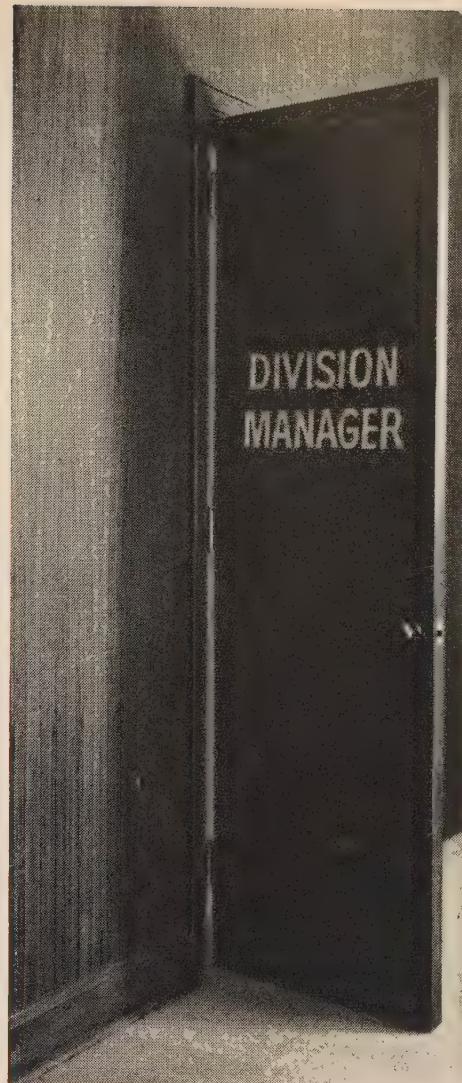
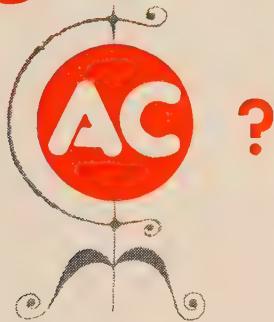
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### FOR SALE:

Vultee BT-13 (A) Aircraft—422 hours since engine major. ADF, Marker Beacon LP, ARC-5 VHF Tranceiver, 24 volt electrical system. Excellent condition, corporation owned and maintained. Make Offer. Contact: Mr. B. Morton, Cornell Aeronautical Laboratory, Inc., 4455 Genesee Street, Buffalo 21, New York.



# How far can an engineer go at

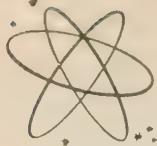


Someday your name may go on the door of a top-management office of the AC Division . . . or of the General Motors Corporation. This is part of GM's "open door" policy. This means that not only is every GM door open to every employee, but that every open door represents opportunity. Today AC helps fulfill the large demand for inertial guidance systems (with the AChiever) and many other electro-mechanical, optical and infra-red devices. In the future AC will supply even more instrumentation needs—both military and commercial—for the "space era." Your long-range prospects at AC can hardly be equaled. You'll gain invaluable experience working shoulder to shoulder with recognized experts on many assignments. You'll enjoy highest professional status, which can be enhanced by working on advanced degrees at engineering schools located near AC facilities. You can work at AC facilities across the country or around the world. In short, if you are a graduate engineer in the electronic, electrical or mechanical fields, you can go places at AC, because AC is going places. This is worth looking into. Just write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oak Creek Plant, Dept. E, Box 746, South Milwaukee, Wisconsin. It may be the most important letter of your life.

Inertial Guidance Systems • Afterburner Fuel  
Controls • Bombing Navigational Computers  
Gun-Bomb-Rocket Sights • Gyro-Accelerometers  
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AC SPARK PLUG THE ELECTRONICS DIVISION OF GENERAL MOTORS

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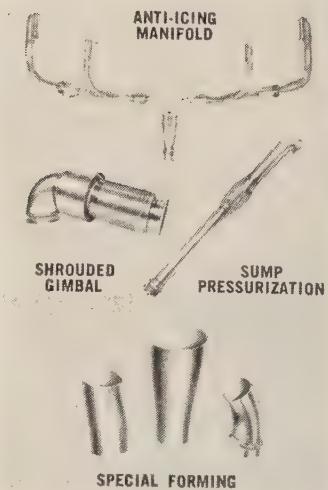


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# TAPEnology cuts jet's roar to hushed whisper



When Convair's new 880 "Jet-Liners" go into scheduled airline service early next year, high frequency noises of the boundary-layer effect and the exhaust from the four powerful General Electric CJ-805 turbojet engines—somewhat suppressed by extra-thick fuselage skins—will be further hushed to a soft whisper inside the cabin by a newly developed "SCOTCH" Brand Tape.

More than 1¼ miles of this tape—"SCOTCH" Brand No. 428 Sound Damping Tape—is applied directly to inside of fuselage panels throughout the "880". A specially developed visco-elastic adhesive between the tape backing and the skin panel reduces metal vibration by converting sound energy into heat energy . . . changes the natural frequency of the panel . . . provides sound damping beyond that possible only by adding either mass or stiffness to the aluminum. One person can do entire application if necessary . . . weight control is precise throughout. Results? "Beyond expectations of acoustic engineers" says Convair.

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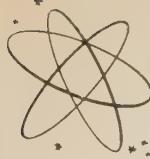
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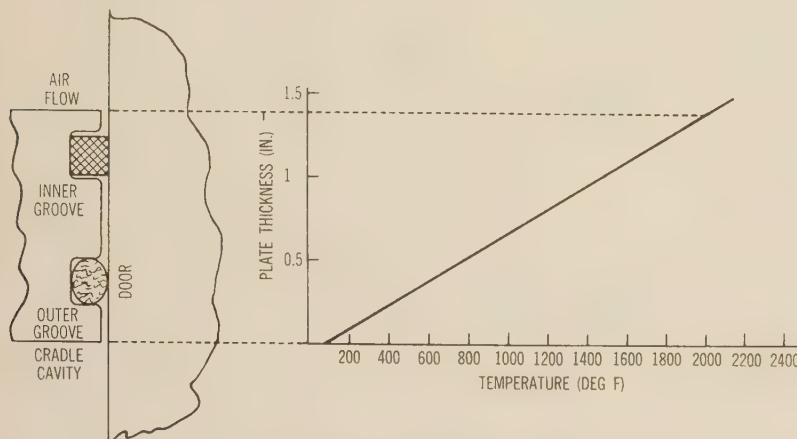
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## equipment briefs



### SQUARE INCONEL ASBESTOS PACKING

A PRIMARY asbestos and Inconel wire packing is being used to seal the edges of a new hypersonic wind tunnel. Although the variable-plate surfaces are subject to high thermal shock—the free-stream air stagnation temperature rises from 60 to 2500 deg F in less than a second—the packing has not been affected.

The movable plates contain two seals that fit into milled grooves in the plate edges and form a pneumatic pressure seal against the side walls of the diffuser box. The square Inconel-asbestos seal is treated with a graphite-base, temperature- and pressure-resistant molysulfide powder to lubricate the movable plates and sidewalls.

To provide a positive pressure seal at the extraordinarily high operating temperatures, the Garlock Packing Co., Palmyra, N.Y., recommends that a square-calendered, braided packing be used. This is a heavy-duty, high pressure and temperature design with a corrosion inhibitor to forestall damage from moisture. Inconel wire prevents rupture even during the most abrupt plate movements or pressure increases.

A round silicone rubber extrusion is used as a secondary plate seal. Silicone rubber can be used because the temperatures at this seal never go beyond 500 deg F. Write in No. 51 on Reader Service Card for more information.

The big advantages of this setup are that the flying instructor for preliminary training is to be eliminated and that insurance rates will be substantially decreased, because of the reduced hazard. It will also be possible to carry out operations in bad weather.

More important in the light of Gyrodyne's R&D on remote-controlled and automatically stabilized systems is that the tethering rig simplifies the problem of testing pilotless 'copters. Write in No. 64 on Reader Service Card for more information.



### SWAGING THIN-WALL SUPER-ALLOY TUBING

A COLD - DRAW - FORMING technique has been developed by Boeing Airplane Co., Box 3707, Seattle 24, Wash., for swaging high strength, heat-resistant alloy tubing. Nested aluminum tubing (which is later discarded) is used during the process to keep the super-alloy tubing from collapsing. Boeing reports that its new process has overcome the usual problems of buckling, cracking, wrinkling, bulge, and flare.

The new technique has been used to reduce the end of a two-inch-diameter, 0.01-in-wall welded M-252 tube to a  $\frac{1}{2}$ -in. diameter with a smooth 10-deg taper. This operation involved an eight-stage reduction with interstage anneals.

In reducing the diameter to  $\frac{1}{2}$  in., the wall was thickened to 0.33 in. A standard engine lathe was used as the power source.



### CAPTIVE COPTER RIG

THE largest fixture ever built for testing copters in tethered flight is being erected by Gyrodyne Co. of America, Inc., St. James, N.Y. It is designed to handle a wide range of vehicles weighing up to 25,000 lbs.

The test fixture is built in the form of two 164-ft towers spanned by a 150-ft bridge. The assembly includes cables, winches, and controls.

During tests, the helicopter is suspended from the top of its rotor but is able to operate in essentially free flight. The tethering cable takes over only when the helicopter becomes uncontrollable.



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ing units for four, six or eight wheel vehicles.

Today Rockwell-Standard leads the way for the industry with Timken-Detroit® steering axles, drive axles, tandem axles, trailer axles and transfer cases; and Hydra-Drives® torque converters and power shift transmissions.

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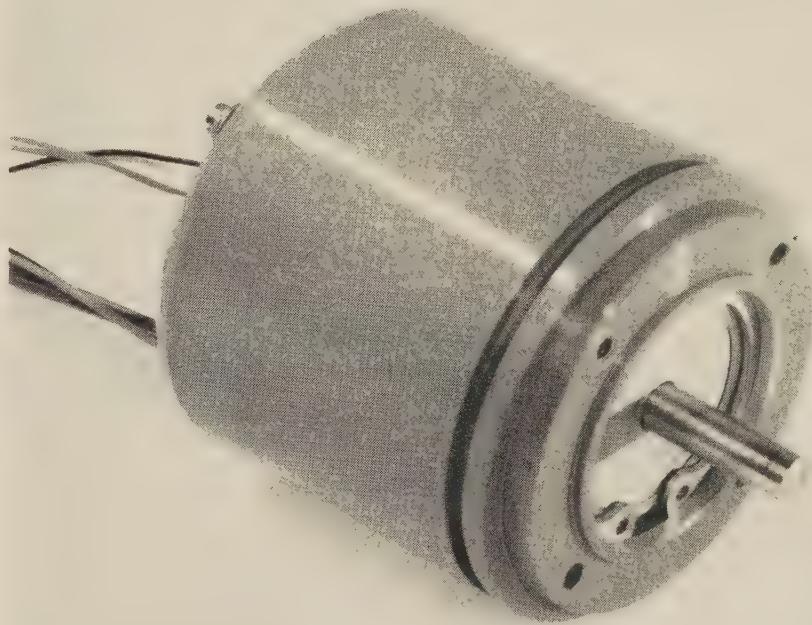
**ROCKWELL-STANDARD**  
CORPORATION



Transmission and Axle Division, Detroit 32, Michigan

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SPACE/AERONAUTICS



### TWO-SPEED SYNCHRO works electrically



OCTOBER 1959

Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J., has developed an electrical two-speed synchro. By producing two electrical outputs from a single-shaft unit, it eliminates the inaccuracies connected with conventional two speed gearing, also the need for an additional unit, installation and maintenance costs.

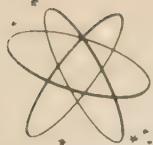
The stator contains two separate windings, one producing the normal signal pattern of one cycle of output voltage, the

other producing eleven cycles, for each rotation of the synchro shaft. The coarse or fine output can be selected through a switching system located outside the unit. The system error can be held to 1.4 minutes or less, and a 350:1 signal-to-null ratio will allow engineers to design systems to the test bench specs of the unit. A new winding design eliminates errors due to clamping and uneven expansion or contraction of the magnetic structure.

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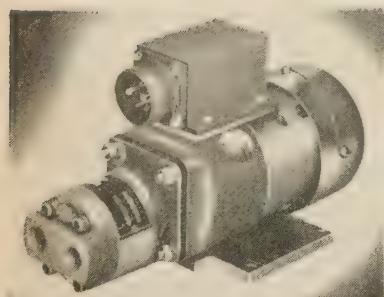
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Randolph Hawthorne  
*Editor*



# product preview

## GEAR PUMP is lightweight

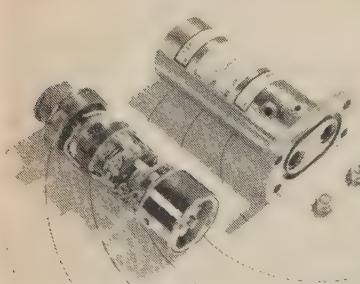


A compact, motor-driven hydraulic pump that, in one application, serves as a power source for the integral loading steps of the prop-jet Electra, weighs 7.9 lbs, says Great Lakes Mfg. Corp., Dept. S/A, 4223 Monticello Blvd., Cleveland, O. Capacity is 0.2 gpm, minimum, at 3000 psi outlet, with nine psi absolute inlet at 26 V.

The piston-loaded gear pump operates in continuous duty cycle at 3000 psi and intermittently at 3450 psi. It is rated for 500 hrs of use. The 28-V, dc motor is an explosion-resistant, fan-cooled type conforming to MIL-M-8609.

**Write in No. 1018 on Reader Service Card**

## EXPLOSIVE INITIATOR is designed for safety



Based on the action of an indexing rotary solenoid the Model 212A Explosive Initiator is designed to the electrical and mechanical safety requirements of military type safety and arming devices, says Beckman & Whitley, Inc., Dept. S/A, San Carlos, Calif. At any time before firing, reception of a "safe" command turns the rotor to make initiation impossible.

The rotary solenoid controls the position of an out-of-line disk rotor located between the initiating element and the final igniting charge. Upon reception of a remotely originating "arm" command, the rotor is positioned to permit a subsequent firing command signal to initiate connected premacord, low energy detonating coil (LEDC), or bulk charges.

**Write in No. 1019 on Reader Service Card**

## THERMAL SWITCH is lightweight

Weighing  $\frac{1}{2}$  oz, this button switch is a high temperature bimetal thermal switch with contacts for either close-on-rise or close-on-fall in temperature. It can be supplied calibrated at 600 deg F max, or down to -20 deg F min with a possible close temperature tolerance of two degrees F under laboratory conditions, says Control Products, Inc., Dept. S/A, 306 Sussex St., Harrison, N.J.

Temperature differential and repeatability for a given switch is about one degree F. An overshoot to 800 deg F or undershoot to -100 deg F can be tolerated, it is said. Hermetically sealed (metal to glass), it will meet the shock and vibration requirements of MIL-E-5272A Procedure I. The overall height is  $\frac{3}{8}$  in.

**Write in No. 1020 on Reader Service Card**

## BEACON TRANSMITTER for satellite tracking

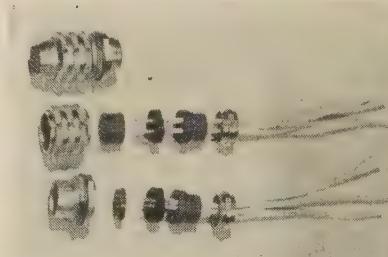


The 30 to 100-mw output rating of this transistorized subcarrier oscillator transmitter designed for satellite or space vehicle tracking and narrow-band telemetry permits line-of-sight operation from 150 to 1000 mi in normal satellite applications, says Applied Science Corp. of Princeton, Dept. S/A, P.O. Box 44, Princeton, N.J. Carrier frequency of the combination device can be chosen from any crystal-controlled frequency in the range of 100 to 150 mc.

Although the transmitter is intended to be amplitude modulated, phase modulation at subcarrier frequencies up to 22 kc can be used, and tracking signals and restricted bandwidth data can be transmitted simultaneously. The 12-oz unit measures  $1\frac{1}{8} \times \frac{3}{4}$  in., and it uses 250 mw from a 20-V supply.

**Write in No. 1021 on Reader Service Card**

## SNAP-IN CONNECTORS have removable contacts

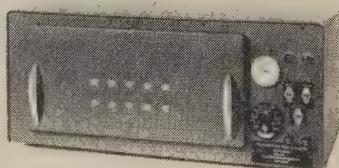


Removable contacts, silicone inserts and crimp-type terminations are featured in the DS series of lightweight, snap-in connectors, says The Deutsch Co., Dept. S/A, 7000 Avalon Blvd., Los Angeles 3, Calif. Pins and sockets are silver plated and sockets have contact springs completely hooded to prevent malfunctioning from probing or spring pop-out.

The connectors, available in seven-, 19- and 37-pin and socket arrangements, are vibration damped, permit no air leakage at 30 psi differential, and withstand temperatures from -100 to over 300 deg F.

**Write in No. 1022 on Reader Service Card**

## TEMPERATURE CHAMBER weighs 40 lbs



The Model 6545 W is a revolutionary, portable temperature testing chamber that automatically cools to -100 deg F in about five min and heats to 500 deg F in 30 min, according to Delta Design Engineers, Inc., Dept. S/A, 3163 Adams Ave., San Diego 16, Calif. The 40-lb device has an anticipator thermostat that keeps the desired temperature to within plus or minus two deg.

Test capacity is  $16 \times 7 \times 7$  in., and the interior is stainless steel. The device has glass fiber insulation. Liquid carbon dioxide is the cooling agent, and a nichrome filament (650 W) is used to attain maximum heating temperatures. A centrifugal blower-type air circulator helps maintain temperature uniformity. The chamber operates on 115 V, 60 cycles.

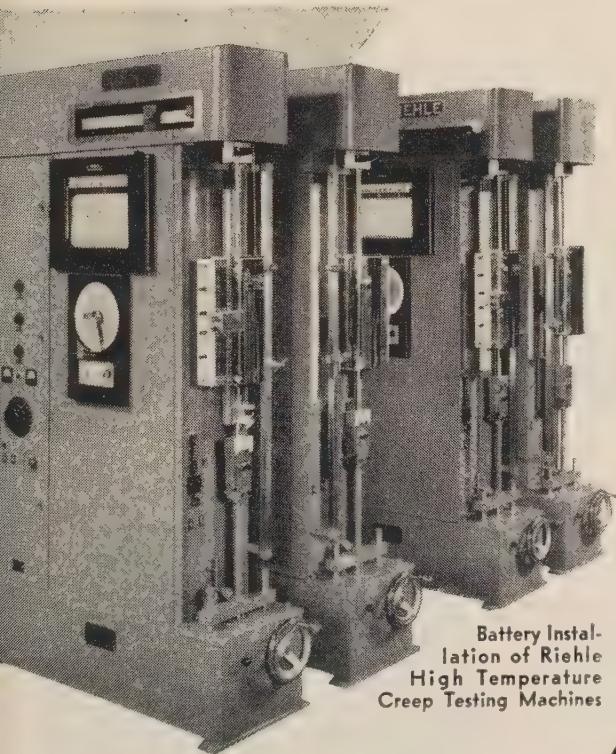
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more on page 268**

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SPACE/AERONAUTICS

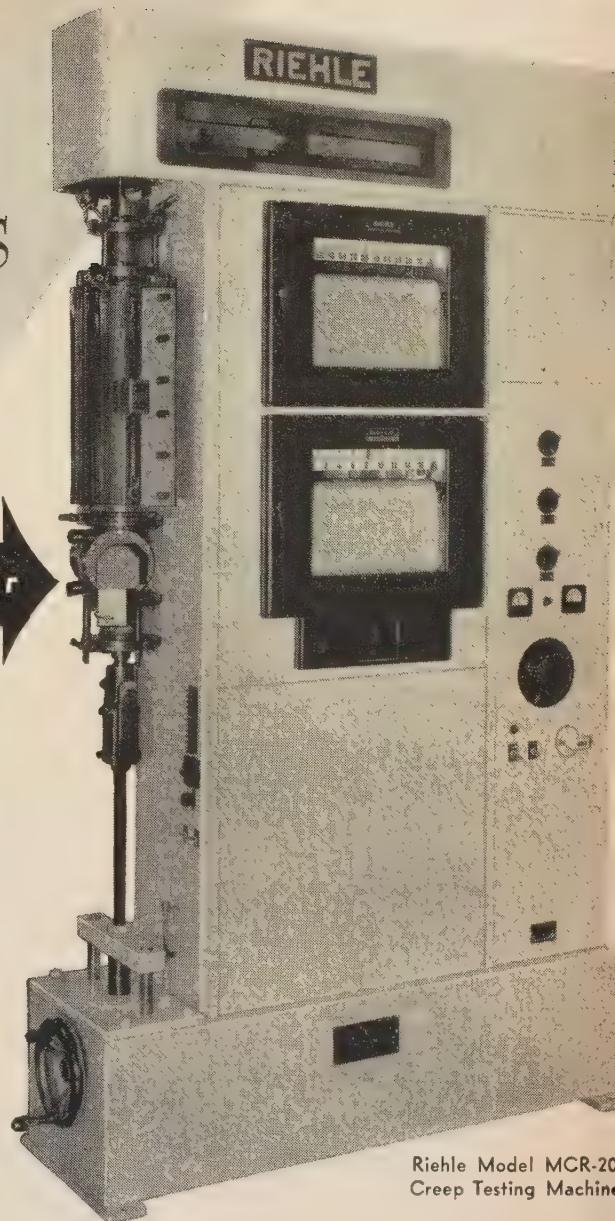
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Battery Installation of Riehle High Temperature Creep Testing Machines



Riehle Model MCR-20  
Creep Testing Machine

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PRODUCT PREVIEW

SERVO VALVE  
has one gas source



This Model 610 four-way Pneumatic Servovalve has two outstanding features that insure reliability: The servovalve first and second stages can receive and pass on particles as large as 200 microns without malfunction; and the first stage hydraulic preamplifier has only one source of gas and cannot become unbalanced due to gas contamination, says Raymond Atchley, Inc., Dept. S/A, 2340 Sawtelle Blvd., Los Angeles 64, Calif.

The new valve features a high-gain push-pull force feedback servo that controls the second stage. The hermetically sealed torque motor is dry (isolated from the gas). It is available with output port area (two orifices in series) of 0.01 sq in. each. Operating pressure is from 300 to 1500 psi. Standard temperature ranges from -65 to 250 deg F. Weight, 11 oz.

Write in No. 1024 on Reader Service Card

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Work on America's most advanced weapon systems

Immediate openings for qualified engineers to initiate and evaluate avionic equipment for future manned aerodynamic and space vehicles.

**Optimum Qualifications:**  
Analysis of Guidance, Radar, Infra-red, Control, and Communications equipment to determine performance and size.

**Minimum Qualifications:**  
Experience in at least one of these fields, plus a degree in electronics, physics, or mathematics.

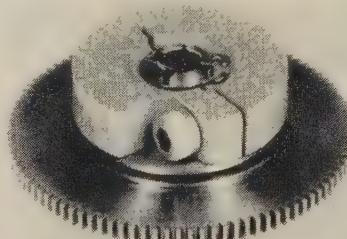
For more information please write to: Mr. P. K. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF

**NORTH  
AMERICAN  
AVIATION, INC.**



### CLUTCH GEAR protects servo mechanisms



Overload damage to gear teeth, bearings and components in servo and instrument mechanisms as a result of shock from sudden stops can be prevented by a new slip clutch gear made by Precision Mechanisms Corp., Dept. S/A, 577 Newbridge Ave., East Meadow, N.Y. The 5/16 in long clutch is self contained and may be clamped to any .125 or .120-in dia shaft.

Standard gears are 96 pitch, ACMA Prec. 1, and sizes range from 66 to 110 teeth. The gear is preset to slip at any desired torque between one and 15 oz-in.

Write in No. 1025 on Reader Service Card  
more on page 270

This is the most accurate, trouble-free

## LEAK DETECTOR

you can buy



*fast...simple...safe*

- Quick and Easy to Operate

Flip a switch and the built-in automatic station does the work for you, electrically (no air supply required) ...lets you make up to 120 tests per hour...safety interlocks eliminate operator error, permits use of non-technical personnel.

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Constant  $10^{-10}$  cc/sec accuracy guaranteed by the patented VEECO VEETUBE®...it cleans itself...uses safe, inert helium as tracer gas.

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Each MS-9 undergoes a full week (168 hrs) of test run and inspection before shipment.

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WITH/WITHOUT  
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FREE MS-9 BROCHURE  
contains full details on  
performance, specifications,  
operation and  
advantages. There is an  
MS-9 series Leak Detector  
to fill your exact  
need. Write Department  
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HIGH VACUUM & LEAK DETECTION EQUIPMENT

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SPACE/AERONAUTICS

# HONEYCOMB "EYES" FOR HUSTLERS

AERONCA PRODUCES ALUMINUM HONEYCOMB RADAR REFLECTORS FOR B-58 BOMB-NAV SYSTEM

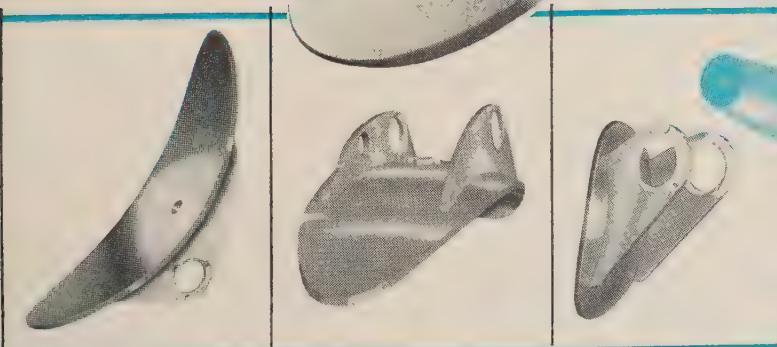
To withstand the environmental factors of supersonic performance, the Convair *Hustler* utilizes a variety of honeycomb sandwich structures for major airframe and sub-system components. Its bomb-nav system's high-gain radar antennas exemplify these technologically advanced structures.

Aeronca produces the precision parabolic radar reflectors as a D-T-P\* "envelope" project, on a subcontract basis. Highly specialized skills and facilities are required to meet their stringent specifications.

A pioneer in honeycomb sandwich fabrications, Aeronca has the versatile, integrated facilities necessary to supply weapon system envelopes efficiently, economically and on-schedule.



8632-AC



\*Fabricated to curvature tolerances of  $\pm .005"$ , these precision honeycomb structures illustrate Aeronca's coordinated Design-Tool-Produce capability.

Operational expansion has created openings for additional senior engineers. Write to W. W. Gordinier, Personnel Manager.

Write in No. 172 on Reader Service Card at start of Product Preview Section



manufacturing corporation

1724 GERMANTOWN ROAD • MIDDLETON, OHIO

**COMPASS COMPARATOR  
is transistorized**

# CERAMICS

For **FUEL SHUT-OFF  
VALVES**

**FUEL NO-AIR VALVES**

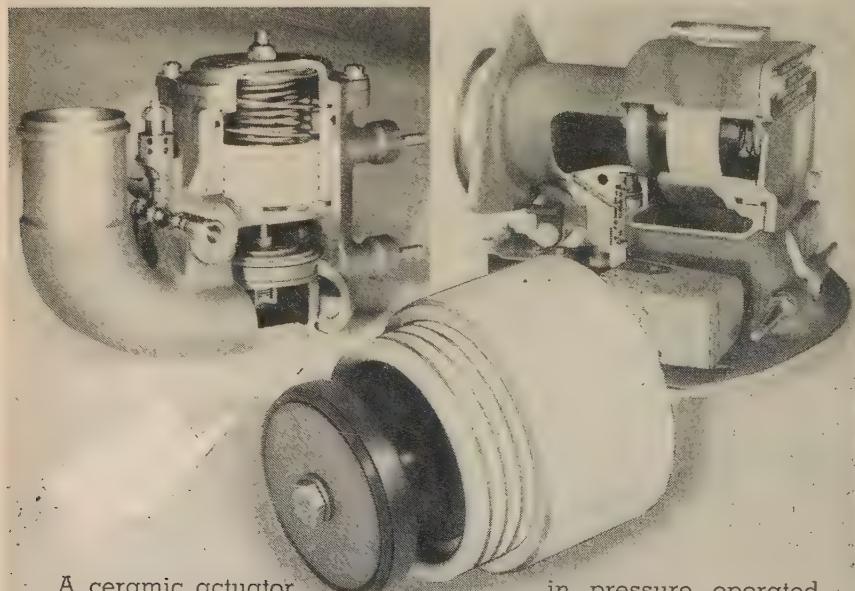
**VENT VALVES**

**CERAMICS**

**CERAMICS**

**CERAMICS**

- are impervious to the rugged environmental conditions imposed on fuel systems components
- will not deteriorate at high temperatures
- provide infinite corrosion resistance in fuel and other corrosive fluid media



A ceramic actuator in pressure operated valves eliminates the necessity for elastomeric diaphragms and close-fitting metal parts. Provides maximum durability and reliability in severe environmental applications.

Aero Supply has pioneered in the application of ceramics to aircraft fuel system components . . . so may we suggest you discuss your very next specification with us? Request technical bulletin #8-2759.

A NEW Development Of The

**AERO SUPPLY MFG. CO. INC.  
CORY, PENNSYLVANIA**

ELECTRO-MECHANICAL DEVICES • ENGINEERED FLUID CONTROL SYSTEMS • PRECISION MANUFACTURING

Write in No. 173 on Reader Service Card at start or Product Preview Section

**POWER SUPPLY  
is portable**

This Moeller Model 21 Isolated Power Supply provides an output isolated from line voltage and line ground. It provides zero-20V at one ampere regulated dc power by means of transistorized circuitry. The distinctive feature of this supply is that the isolation provided permits precise and dynamically accurate results when used in connection with bridge-type transducers; such as strain gauges, accelerometers, resistance thermometers and pressure gauges, states Moeller Instrument Co., Dept. S/A, 132nd St. and 89th Ave., Richmond Hill 18, New York, N.Y.

A special output receptacle is provided in the unit that permits remote shielding of power cables. The supply is portable and is suitable for rack mounting three supplies per standard rack. It measures seven by nine by 14 in.

Write in No. 1027 on Reader Service Card  
**more on page 273**

Westinghouse  
electronic components...  
for uncompromising  
reliability



## 1400% more reliability through research

Original research in electronics and related fields is constantly in progress at Westinghouse. Here, the latest development—moletronics—has reduced parts from 14 to 1, soldered connections from 15 to 2, in a light telemetry subsystem. The improvements in reliability when products like these reach automatic production are boundless.

You can take advantage of this kind of component research and development by specifying Westinghouse high-reliability components for all of your circuit designs. At Westinghouse, you can draw not only from a wealth of off-the-shelf components, but also from a vast stock pile of knowledge, experience, and research which makes "break-throughs" like molecular electronics a reality.

For all of your needs in ultramodern components, contact your local Westinghouse sales engineer or write: Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

*Old and new—At left, a present semiconductor. At right, dendritically grown germanium crystals which perform the same function. Westinghouse expects to build several different electronic functions into single tiny slabs like these.*

J-92028

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Control Devices • Instrumentation • Laminated Plastic Forms (Micarta®) • Magnetic Amplifiers • Magnetic Materials • Power Supplies • Static Inverters • Semiconductors • Transformers and Components • Tubes: Cathode-Receiving-Power-Nuclear Control

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# Westinghouse



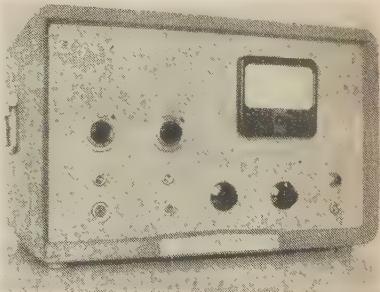
WATCH "WESTINGHOUSE LUCILLE BALL DESI ARNAZ SHOWS" CBS-TV FRIDAYS

*Toward the preparation of man for the first steps into deep space, the Martin space medicine research program and space ecology laboratory facilities—now in development at the Denver Division—are among the most advanced activities in the free world.*

*Especially noteworthy is the Martin Lunar Housing Simulator. This will be a self-sustaining environmental closed system which will permit advanced study of survival requirements and techniques applicable to airless lunar or planetary conditions.*



**ANEMOMETER**  
is hot-wire type

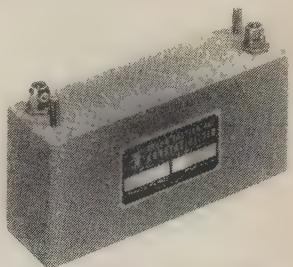


Air-flow velocity in jet engine components, fans, pumps, and like devices may be accurately studied with the Model 60B hot-wire anemometer, according to Shapiro & Edwards, Dept. S/A, 1130 Mission St., South Pasadena, Calif. The instrument's design is based on the air stream's ability to absorb heat from an electrically heated, thin wire filament, which forms one leg of a Wheatstone.

A feedback circuit maintains constant resistance and temperature of the wire, and wire current is a measure of the instantaneous velocity. The self-contained anemometer is simple to operate and needs only an output indicator, such as an oscilloscope, for presentation of the fast variations in the flow. Frequency response extends from dc to ten kc, and accuracy is one per cent.

Write in No. 1028 on Reader Service Card

**CRYSTAL FILTERS**  
cut false triggering

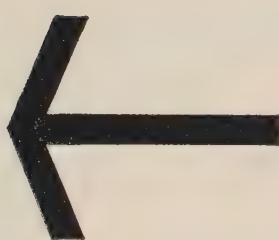


The crystal filters in the Model 354 Series achieve selectivity at the rf frequency, thus eliminating false triggering due to undesired adjacent signals, says Hycon Industries, Inc., Dept. S/A, 75 Cambridge Parkway, Cambridge 42, Mass. The filters, made for the 37-mc range, are designed to be directly paralleled, with no isolation padding networks to cut RF losses.

Specifications for the pre-selection filters include: bandwidth at six db, attenuation six kc min; bandwidth at 60 db, attenuation 20 kc maximum; midband insertion loss, three db maximum; and passband response variations,  $\pm\frac{1}{2}$  db. The operating temperature range is -40 to +85 deg C.

Write in No. 1029 on Reader Service Card

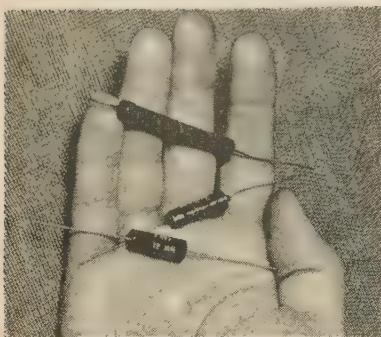
more on next page



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BALTIMORE · DENVER · ORLANDO

*Martin-Denver  
is one of the  
eight divisions  
of The Martin Company*

**TINY RESISTORS  
built in module design**



What is reported to be the first commercial production of resistor elements developed from the micro-module concept has resulted in resistors ten times smaller and lighter than present resistance components, says Daystrom-Weston Instruments, Dept. S/A, 614 Frelinghuysen Ave., Newark 5, N.J. Basically, the micro-minature resistors are a solid state material in the form of a .35-in sq ceramic wafer, with a thickness of about .0001 in.

Each resistor element contains four resistors and weighs 50 mg. Resistance characteristics are inscribed as isolation lines in the wafer substrates to

produce the resistance characteristics desired. The highly reliable and stable resistors can be designed for values of ten ohms to one megohm, and multi-layer structures can extend this range. Single or double-sided elements can be designed and various circuitry combinations can be used with the basic micro-element.

Write in No. 1030 on Reader Service Card

**TRANSFORMER  
is differential type**

A large bore linear variable differential transformer for special applications requiring relatively large clearance between transformer and core is announced by Schaevitz Engineering, Dept. S/A, Route 130 & Schaevitz Blvd., Pennsauken, N.J.

The new unit is suitable for flow meters, level metering systems, pressure transducers, etc., where the core must be separated from the transformer by a glass or other non-magnetic tube. The transformer has a linear range of one inch in either direction from null position, and gives a stepless output with less than one per cent deviation from a straight line at any position of the core throughout its full travel.

Write in No. 1031 on Reader Service Card

**SIMULATOR  
for L- or S-Band**



The Signal Environmental Simulator generates a realistic high density signal environment in the 200 to 350 Mcps band, L-band or S-band. This unit simulates 8 non-voice radiators, each tuneable over a 100 Mcps range, says Haller, Raymond, and Brown, Inc., Dept. S/A, Science Park, State College, Pa.

On each of the 8 channels, azimuth bearing of the simulated arriving signal is arbitrary and adjustable. Various antenna patterns may be used on each channel. Each channel has adjustable PRF, pulse width, and scan rate. Eight single-channel output and one mixed output are provided.

Write in No. 1032 on Reader Service Card  
**more on page 276**



# TELEFLIGHT® NEW Model 181 AIRBORNE PRESSURE TRANSDUCER

Now a NEW Taber TELEFLIGHT, weighing less than 12 ounces has been designed with an adapter that permits an amplifier to be built in to increase output signal to five volts as used in telemetering systems. BONDED STRAIN GAGE construction makes it relatively insensitive to vibration or shock. Resolution is INFINITE. Handles extremely corrosive media, including fuming NITRIC ACID.

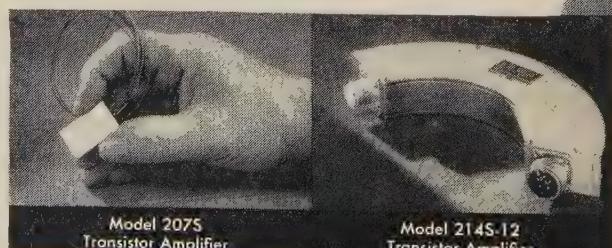
Features Pressure Cavity clean-out and standard built-in pressure overload protection. Pressure ranges: 0-250, 0-350, 0-500, 0-750, 0-1,000 PSI. Linearity 0.3%, Hysteresis 0.25% of F.S. at any given point, Ambient Temperature -100° F. to +275° F.

Taber also produces a complete line of Miniature Transistor Amplifiers. Voltage, Power, Servo & Audio Amplifiers also available.

Write or telephone for literature and prices.

**TABER INSTRUMENT CORPORATION**

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Write in No. 175 on Reader Service Card at start of Product Preview Section

versatile...adaptable...simplest,  
most efficient equipment yet devised  
for single or multiple  
electrical and electronic systems checkout  
fixed base or portable,  
using identical modular components  
for field or factory test and maintenance  
...currently in production,  
federal stock listed

## New Adaptive Systems Analyzer

WRITE... Honeywell Aeronautical Division (671)

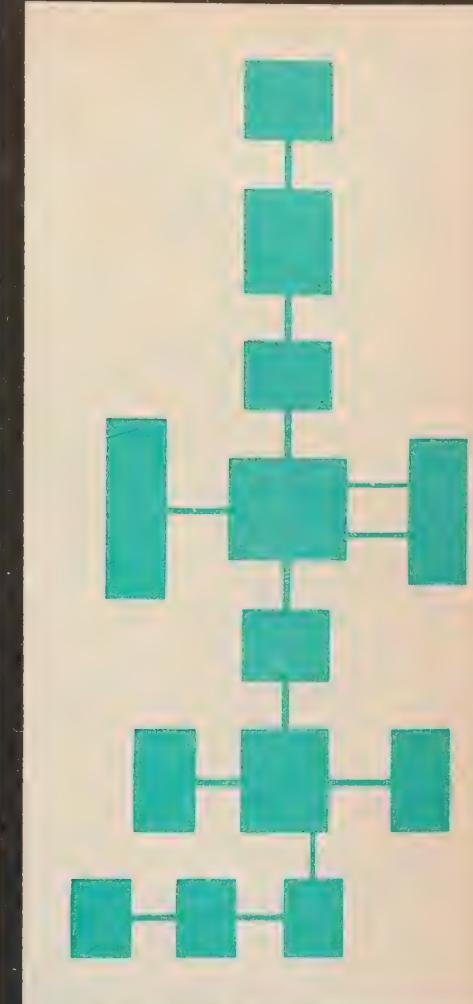
2600 Ridgway Road

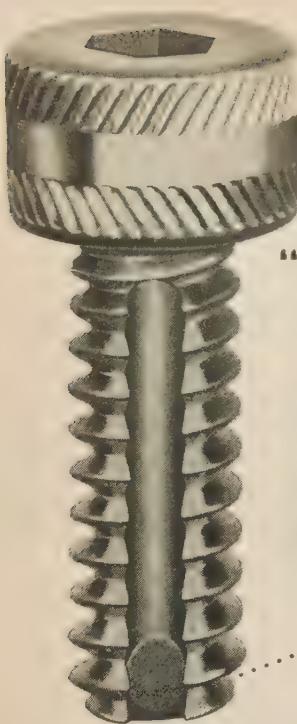
Minneapolis 13, Minn.

# Honeywell

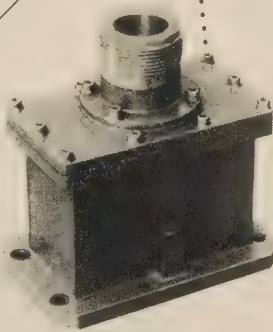


Military Products Group





**"LONG-LOK<sup>®</sup>**  
self-locking screws  
eliminated damaged  
recesses in  
assembling our  
waveguides" ... says  
Tamar Electronics.



This nationally known specialist in electronic countermeasures found that the gradual torque build-up of LONG-LOK Self-Locking Screws prevented destructive torque impact when using pneumatic or power drivers.

LONG-LOK Self-Locking Screws also eliminated lockwire and lock washers.

They are heat and vibration resistant, have wide temperature range and high reusability.

They meet MIL-F-18240 specifications and can be head-marked for self-lock identification.

LONG-LOK Self-Locking Screws can speed and improve your assembly operations — provide important savings in time and labor — assure highest reliability of component and system

*Write for Catalog LL-59*



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CORPORATION

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UPton 0-6335 TWX S MON 7146

*Write in No. 177 on Reader Service Card*

### POWER TRANSISTOR has high current rating

Designated 2N1162 through 2N1165, these power transistors are germanium PNP, alloy junction power transistors with collector common to the case. They are designed from high currents switching audio applications, featuring a rugged internal design hermetically sealed standard TO-3 package, says **Motorola Inc., Semiconductor Products Div., Dept. S/A, 5005 East MacDowell Rd., Phoenix, Ariz.**

High current gain at 25 amps conservative maximum voltage ratings and low saturation resistance make these units highly efficient and reliable for switching applications.

*Write in No. 1033 on Reader Service Card*

### SOLID-STATE LINE PRINTER for computer application

This high speed printer is integrated with the Burroughs 220 electronic data processing system and will select, edit, and print out data from a computer or magnetic tape at rates up to 1500 lines per minute, says **Burroughs Corp., Electro Data Div., Dept. S/A, 460 Sierra Madre Villa, Pasadena, Calif.**

Effective output speeds have been greatly increased by the 100-word memory of the buffer, which allows simultaneous data loading and final printing. Control over final printing format includes line spacing, skipping, and other versatile paper movement functions. The vocabulary consists of 51 solid-face characters, which print in lines of 120 positions. Printing density is 10 characters per inch.

*Write in No. 1034 on Reader Service Card*

### MINIATURE TRANSMITTER for space vehicles

This miniature, low-power combination sub-carrier oscillator transmitter has a carrier frequency which can be chosen from any crystal-controlled frequency in the range of 100 to 150 Mc, says **Applied Science Corp. of Princeton, Dept. S/A, P.O. Box 44, Princeton, N.J.**

The output power of 30 to 100 mw allows line of sight operation from 150 to 1000 miles in normal satellite applications. The unit is only 1½ in. by 3¼ in. dia. and weighs about 12 oz.

*Write in No. 1035 on Reader Service Card*

### ANGLE OF ATTACK INDICATOR is integrally-lighted

This Angle Of Attack Indicator was designed as an integrally-lighted high performance, light-weight replacement of instruments manufactured to MIL-I-18856, says **Bendix Aviation Corp., Montrose Div., Dept. S/A, So. Montrose, Pa.**

A 3-stage transistorized servo amplifier is used, featuring silicon power transistors. The unit is designed for clamp mounting on a non-shock panel. A removable plate permits adjustment of actuation points without disassembly.

*Write in No. 1036 on Reader Service Card*

### PRECISION FILM RESISTOR is epoxy coated

The N style resistor, produced in ½ and ¼ watt sizes, provides excellent insulation and moisture resistance and conforms with MIL-R-10509C, characteristic B, says **Corning Glass Works, Electronics Component, Dept. S/A, Bradford, Pa.**

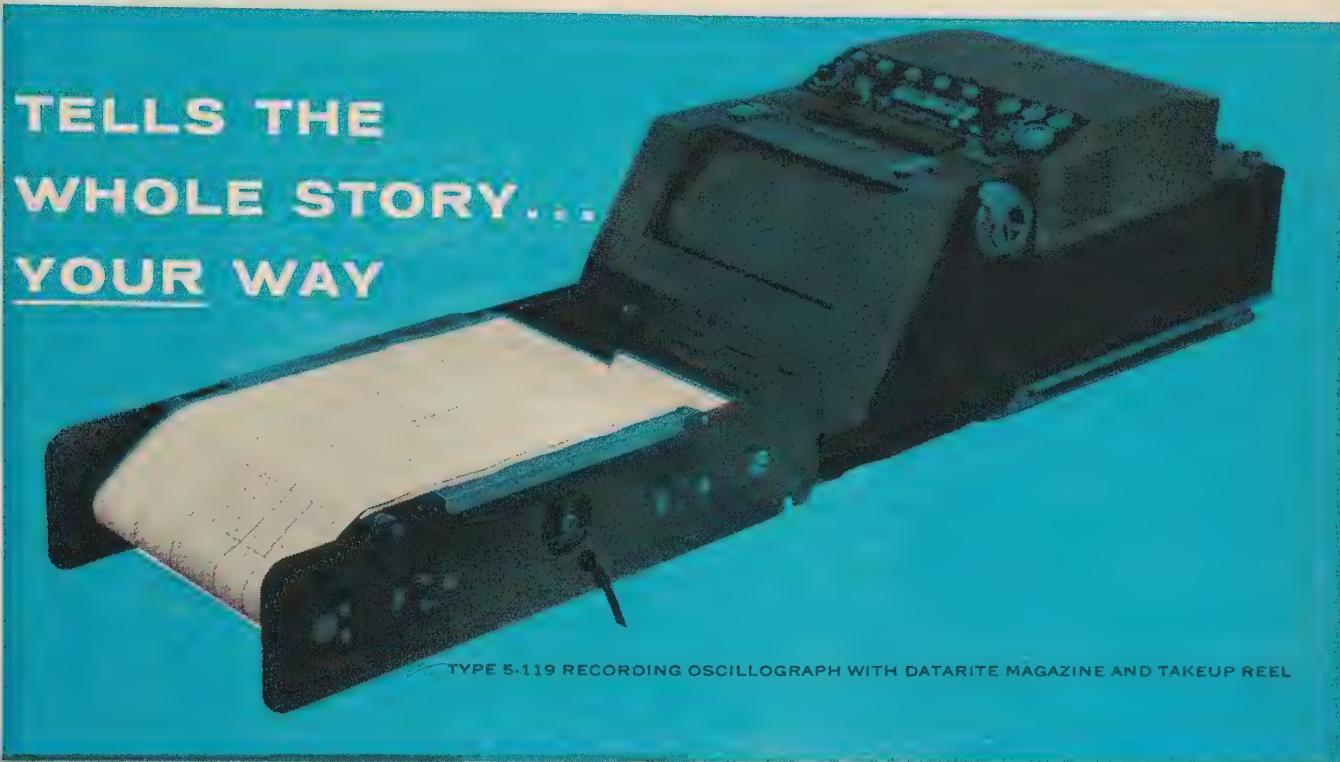
The resistors are dip-coated with a new epoxy, which will withstand chlorinated hydrocarbon solvents used in cleaning flux from printed circuits boards.

*Write in No. 1037 on Reader Service Card*

**more on page 278**

SPACE/AERONAUTICS

## CEC's 5-119 Oscillograph with 3 interchangeable magazines



TYPE 5-119 RECORDING OSCILLOGRAPH WITH DATARITE MAGAZINE AND TAKEUP REEL

Here's the universal engineering research tool that provides unprecedented versatility in monitoring high-frequency, dynamic data. CEC's 5-119 Recording Oscillograph enables engineers to use the photographic recording process best suited to their specific test requirements.



### The 5-119 converts quickly to:

A DIRECT-PRINT RECORDER using an internal high-actinic light source and a 5-051 Slot-Exit Magazine that clearly resolves writing speeds in excess of 50,000 ips... produces records on standard direct-print papers without chemical processing.

AN AUTOMATIC PROCESSING RAPID-ACCESS INSTRUMENT using a 5-036B DATARITE Magazine that processes standard photographic films or papers in the shortest time of any known oscillographic process... provides ready-to-read test results in 0.8 second after exposure.

A CONVENTIONAL OSCILLOGRAPH using a 5-006A Standard Magazine and 12-inch recording films or papers that are processed following the record run.

The 5-119 provides 36 or 50 independent data input channels and wide record-speed and frequency ranges. For complete details call your nearest CEC sales and service office, or write for Bulletin CEC 1536-X6.

Electro Mechanical Instrument Division

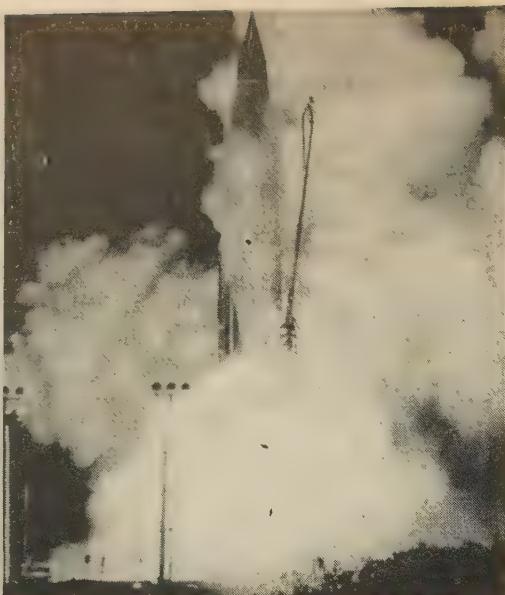
**CEC**

**CONSOLIDATED ELECTRODYNAMICS** 360 Sierra Madre Villa, Pasadena, California

Write in No. 178 on Reader Service Card at start of Product Preview Section

# ON EVERY ATLAS COUNTDOWN

## PRESSURE GAUGES ARE CONSULTED

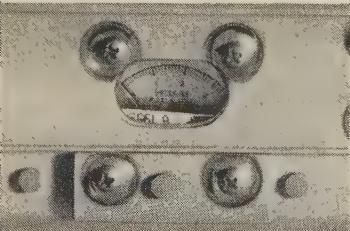


### **Used for Readout of Gas Pre-Charge in Hydraulic System Accumulators**

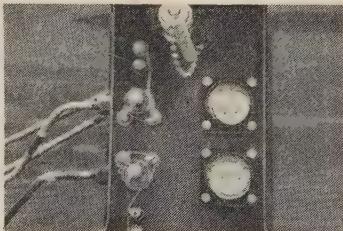
Complete reliability, freedom from jamming even under severe overloads, resistance to shock and vibration, the ability to keep functioning accurately whether setting in the desert sun or subjected to extreme cold . . . these are some of the reasons you will find 6 RMC-Lindsay High Pressure Gauges on each Convair Atlas.

These gauges must withstand shock tests of 100Gs. They are checked for accuracy in vibration tests ranging from 10 to 2,000cps at 35Gs and at ambient temperatures from -65°F to +275°F. There is no linkage, no gear train to disintegrate or to cause pointer vibration. The indicating pointer is attached directly to the end of the helical bourdon coil.

RMC Gauges are built to the most exacting laboratory standards for accurate performance under the most rigorous conditions encountered in modern industry, in jet aviation, in astronautics.



RMC Gauge for the booster engine hydraulic system accumulator is flush mounted on the booster engine compartment for easy reading from the outside.



RMC gauges used on sustainer of engine hydraulic system are mounted on the side of the missile fuel tank beneath a maintenance access panel.

If you have a high pressure gauge problem let RMC engineers work with you in its solution. Write, wire or phone:

**ROCHESTER MFG. CO. OF CALIFORNIA**  
1401-b S. Shamrock Avenue, Monrovia, California

**ROCHESTER MANUFACTURING CO., INC.**  
224 Rockwood Street, Rochester 10, N. Y.

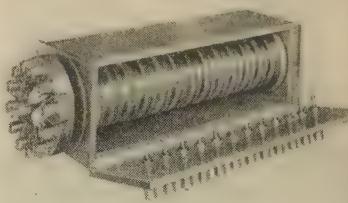
**LINDSAY PRESSURE GAUGES**

#### NEW RMC PLANT IN MONROVIA

The new RMC Monrovia, California plant has been specifically designed for full scale plant production of precision instruments without sacrificing laboratory production standards.

Write in No. 179 on Reader Service Card at start of Product Preview Section

### **SLIP RING ASSEMBLY handles high voltages**



The 12 slip rings and brushes in the 21 KV slip ring assembly are designed to carry 50 ma at up to 21,000 V, ring to ring and ring to ground, says Genisco, Inc., Dept. S/A, 2233 Federal Ave., Los Angeles 64, Calif. Careful proportioning of rings and terminals prevents corona, and the terminals also serve as controlled air gaps that break down at voltages in the vicinity of 28 kv to protect insulation surfaces from flashover.

The rings are rhodium plated for both durability and electrical properties, and terminals are chrome plated. The assembly is about 8x8x30 in.

Write in No. 1038 on Reader Service Card

### **SWITCH-TRANSDUCERS span 0.5 to 4000 psi**



This Pressure Switch-Transducer 1500 series, has all moving parts contained in an aluminum housing, environmentally-sealed by O-rings at each end. It weighs three ounces and senses pressure levels of from 0.5 to 4000 psi. Eight switches cover the complete pressure span, says Haydon Switch, Inc., Dept. S/A, Waterbury 20, Conn.

The unit meets MIL-E-5272A. The entire assembly is resistant to corrosive operating media. An optional mounting bracket provides vibration isolation up to 2,000 cps and up to 50 g's.

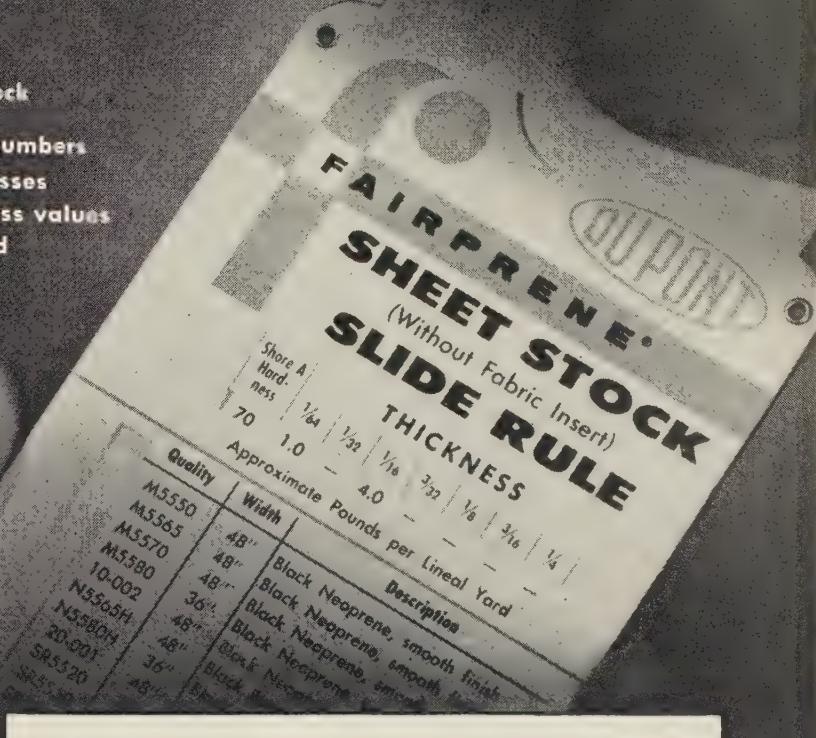
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more on page 282

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- colors • finishes • standard thicknesses
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\* Fairprene is Du Pont's registered trademark for its coated fabrics, sheet stocks and cements.

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Write in No. 181 on Reader Service Card →

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Fabrics Division, Dept. DM-44, Wilmington 98, Delaware

Please send me FREE:  
"Fairprene" Slide Chart

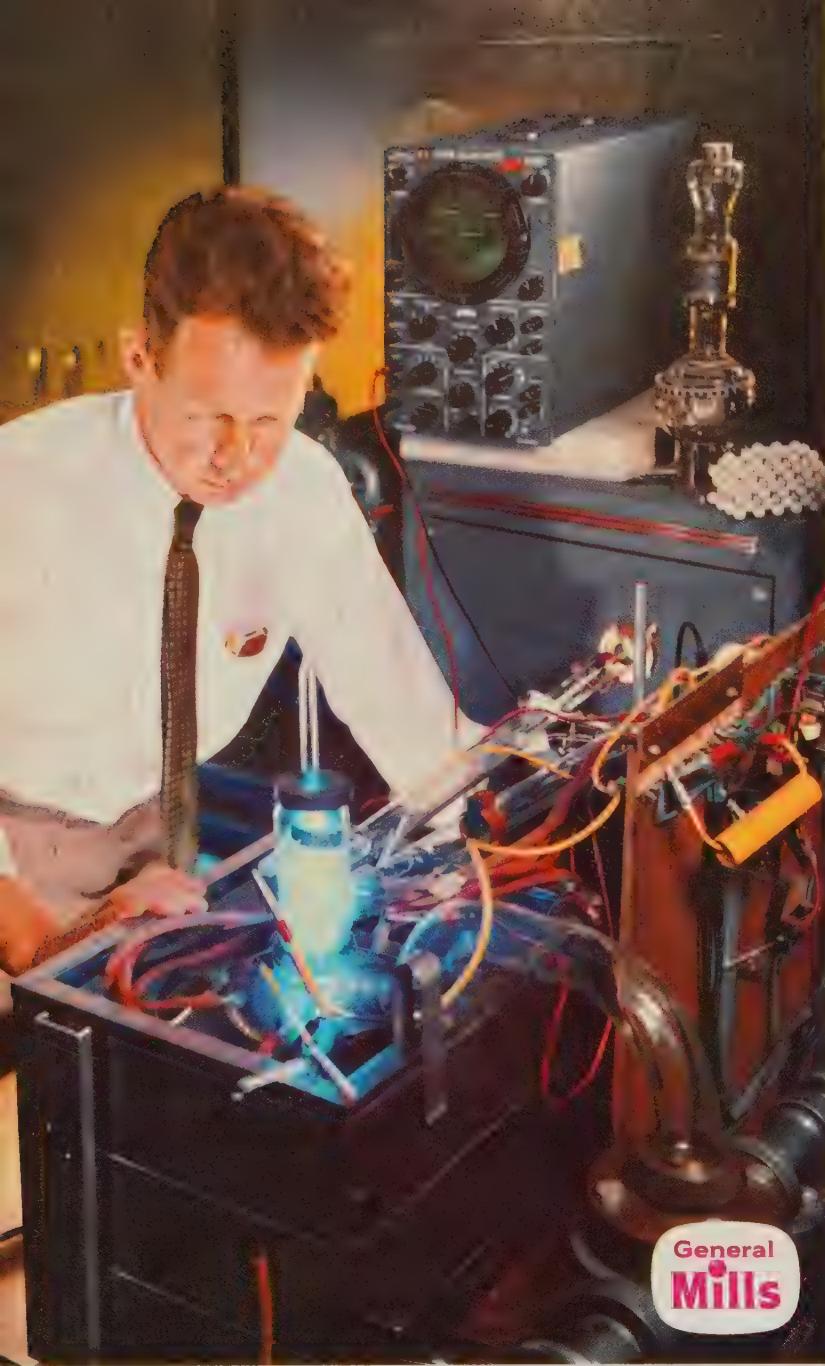
Booklet on "Fairprene" elastomer-coated fabrics and sheet stocks.

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Company \_\_\_\_\_

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City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_



This scientific pioneer is our Dr. G. K. Wehner, designer of the "space chamber" which he uses here to determine the "sputtering" or disintegration rate of molybdenum under

bombardment from atoms moving at 25,000 mph hundreds of miles above the earth. His studies can have bearing on materials which will be used in future space vehicles.

## General Mills scientists are helping today to

The Mechanical Division of General Mills is contributing to man's knowledge of space through work in the vast field of geophysics. Important effort is directed toward increased knowledge of space phenomena vital to the future of space travel.

Our research activities cover broad areas in physics, chemistry, mechanics, electronics and mathematics. Some of the studies repre-

sentative of these activities are: ions in vacuum, deuterium sputtering, dust erosion, magnetic materials, stress measurements, surface friction and phenomena, trajectory data and infrared surveillance.

In our engineering department, current projects include: airborne early warning systems, micro wave radar test equipment, antennas and pedestals, infrared and optics, inertial



**man reaches the moon . . .** illustration from a book written for General Mills by Willy Ley.

## pave the way for tomorrow's trip to the moon

guidance and navigation, digital computers. Our entire manufacturing department is geared to produce systems, sub-systems and assemblies to the most stringent military requirements. Our people have a wealth of

experience in complex military projects. We will be happy to discuss with you the many ways in which our research, engineering and manufacturing capabilities can serve you. Write for more information.

### MECHANICAL DIVISION

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*To wider worlds — through Intensive Research • Creative Engineering • Precision Manufacturing*

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**Mills**

work in the fields of the future at NAA



## TRAINING EQUIPMENT DESIGN

The Los Angeles Division of North American Aviation—Weapon System Contractor for the nation's two most advanced manned weapon systems, the B-70 and F-108—has top-level positions available for

### Training Simulator Designers

These highly-qualified engineers will coordinate and monitor the over-all design of training simulator equipment for the most advanced weapon systems projects.

Background preferred: Graduate Electrical Engineer with minimum of four years' experience in design of analog and digital computers with application to simulation requirements.

For more information please write to: Mr. P. K. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF

**NORTH AMERICAN AVIATION, INC.**

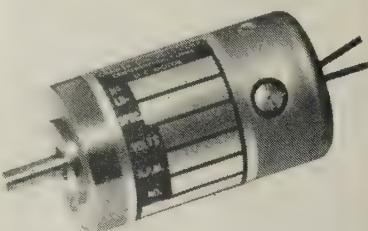


Check Employment Inquiry Form on Page 233

282

## PRODUCT PREVIEW

**DC MOTOR**  
is subminiature

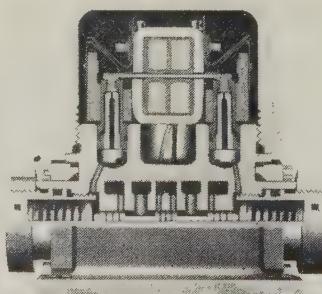


High torque output at high speeds may be obtained from the very small, light Type 810 permanent magnet dc motor, according to Cramer Controls Corp., Dept. S/A, Centerbrook, Conn. The units will operate on any specified dc voltage between three and 30 V, and armatures are wound for any desired no-load motor speed between 5000 and 20,000 rpm at the specified input voltage.

Working torques are in the range of 0.5 to 0.1 oz-in. between the output speeds of 5000 and 15,000 rpm, and internal gear trains are available to permit higher torque at reduced output speeds. Speed is held to plus or minus two per cent for a  $\pm 20$  per cent voltage variable from no load to rated load.

Write in No. 999 on Reader Service Card

### NOZZLE VALVE cuts missile malfunction



Greater assurance against first stage missile malfunction due to oil contaminants is offered by this shrouded nozzle servo valve, according to the Bendix-Pacific Div., Bendix Aviation Corp., Dept. S/A, 11600 Sherman Way, North Hollywood, Calif. The design provides for the channeling of oil away from the torque motor while retaining the superior response and temperature stability advantages of wet coil configurations.

A concentric outer shroud surrounds the first stage nozzles. Nozzle flow is returned through the passage between shroud and nozzle. Since there is no return passage from the torque motor, all nozzle flow returns in this way after the chamber is filled.

Write in No. 1000 on Reader Service Card  
more on page 286

**TAVIS**  
**VARIABLE RELUCTANCE**  
**TRANSDUCERS**  
FOR AIRCRAFT, MISSILE  
AND TEST  
APPLICATIONS

1-300  
SERIES



Tavis pressure pickups — transducer used with sub-carrier oscillators in telemetry systems for accurate data recording under conditions of high acceleration vibration and wide temperature range.

1-100  
SERIES



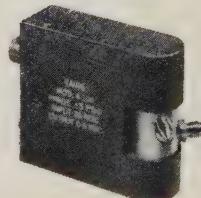
Tavis pressure pickups — minute transducers dual coil construction assures good linearity and high sensitivity — low loss — "U" core coil design. High temperature operation up to 500°F.

2-100  
SERIES



Compact, rugged variable reluctance accelerometer. Outstanding for long term stability over a wide temperature range. High natural frequency for step input measurement.

4-100  
SERIES

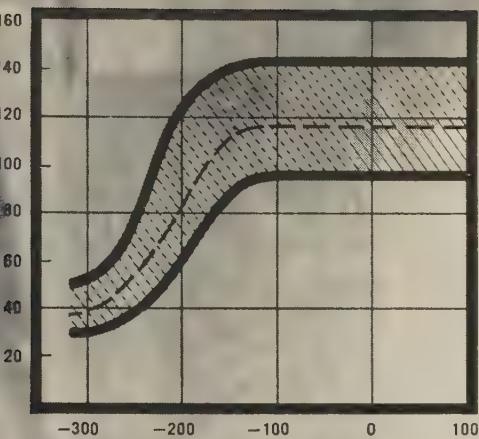


Tavis "DeCeducers" (tm) rugged, compact flexible D.C. input—D.C. output transducers. Unique design, with outstanding mechanical and magnetic hysteresis characteristics. Used in telemetry with voltage controlled oscillators.

For Complete TAVIS Story... Write Today



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SPACE/AERONAUTICS



# ASSIGNMENT: CRYOGENICS

**How Lukens Application Research helps you  
find the right steel plate for the job**

If your assignment is designing equipment for extreme low temperature service—our Application Engineering staff can help you. They research problems of every description from the design stage right through to how the equipment has performed for years after its installation.

Missile components and liquefied gas tanks would be dangerously susceptible to cracking if made from ordinary steel. Seeking economical metals for such applications, Lukens engineers began years ago to watch the performance of nickel bearing alloys in a variety of low temperature equipment. Result: a broad understanding of metal behavior at various low temperature levels.

Examples: In the storage of liquefied oxygen, a tank of *Nine Nickel* steel provided

more than eight years of trouble-free performance. Suitable to minus 320°F. service the steel showed no signs of cracking when removed for inspection. In frigid chambers for testing high altitude aircraft, 2½ percent *nickel steel* is standing up well under pressures as high as 7,000,000 pounds. And in arctic locomotives operating at temperatures to minus 50°F. on rugged mountain roadbeds, main structures of *Lukens "T-1" Steel* have required no maintenance whatsoever.

Lukens Application Engineers know these cases . . . plus many more. *If your assignment is cryogenics, why not let it be our assignment, too?* Contact Manager, Application Engineering, K109 Services Building, Lukens Steel Company, Coatesville, Pa.

**Helping Industry  
Choose Steels  
That Fit The Job**

**ASK FOR LUKENS NINE NICKEL STEEL BULLETIN**

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FOR ELECTRONICS PLANTS...  
FOR AIRCRAFT AND MISSILE BASES...

# NEW 400-CYCLE BUS DUCT

WITH ONLY 1.28 VOLTAGE DROP PER 100 FT!

High-frequency power distribution runs are, for the first time, really practical and economical. Now, a single, central high-frequency generator can completely power tens of thousands of square feet.

At 400 cycles and up, new Westinghouse high-frequency bus duct will deliver power with a maximum voltage drop of only 1.28 volts each 100 feet under full load of 800 amps. Here is performance that cannot economically be begged, borrowed or coaxed out of cable-conduit or other bus duct. Compare this efficiency with conventional systems in which drops of from 7 to 15 volts can normally be expected. Housing of duct is nonmagnetic aluminum

... shields test equipment from radio frequencies originating in duct.

Here is an opportunity, too, to take advantage of all the inherent advantages of bus duct. Power taps every 60 inches over the entire length of duct ... no splicing. No complex wire mazes. Infinitely more flexible and convenient to use. Duct is more quickly and easily installed than cable and conduit.

High-frequency bus duct is immediately available ... and only from Westinghouse. Get in touch with your local Westinghouse sales representative. Or write or wire Standard Control Division, Westinghouse Electric Corporation, Beaver, Pa.

J-30285

**YOU CAN BE SURE...IF IT'S**

# Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS

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**Mission: MAN IN SPACE**

**Filter Application: PROTECT HYDRAULIC CONTROLS**

**Filter: PUROLATOR**

A malfunction in the lines of the hydraulic and pneumatic controls of the X-15 could send it off its programmed trajectory . . . alter the angle of re-entry . . . cause deviation from the ballistic arc.

Purolator filters are on the X-15 to protect the control systems. Three new filtering applications were worked out for North American Aviation, designers and builders of the X-15, by Purolator engineers to meet the space-age requirements of the manned missile.

Filters for crucial aircraft and missile requirements are a specialty at Purolator . . . and every application is considered as crucial as those on the X-15. Draw on Purolator's experience to help you handle your filtration requirements. A phone call or a descriptive letter, with plans or blueprints, will receive prompt attention.

Write in No. 184 on Reader Service Card at start of Product Preview Section

*Filtration For Every Known Fluid*

**PUROLATOR**  
PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

# Introducing a new line of **PRESSURE SWITCH/ TRANSDUCERS!**

- For Aircraft,  
Missile & Rocket  
Applications

- 8 Pressure  
Ranges, covering  
0.5 to 4,000 psi

- Available with  
Optional Vibration  
Isolator

- Qualified to MIL-  
E-5272A Specifications

- External Pressure  
Setting Adjustment

The new Haydon 1500 Series Pressure Switch/Transducer weighs only 6 ounces—yet operates accurately at up to 4,000 psi! Interchangeability of internal modular components permits use of the same small, rugged housing over the complete pressure span from 0.5 to 4,000 psi.

This environmentally-sealed unit is designed for use in all types of pressure systems . . . fuel, hydraulic, oil, pneumatic, chemical and gas. The entire assembly is resistant to corrosive operating media, including water-alcohol solutions, nitric acid and hydrogen peroxide, among others.

**Write now for the new Catalog giving complete data on the Haydon 1500 Series Pressure Switch/Transducer.**



**HAYDON**

*Switch*

INCORPORATED

WATERBURY 20, CONNECTICUT

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## CHECK VALVES for use to 5000 psi

A new series of check valves for rugged operation in hydraulic systems up to 5,000 psi comes in both the subplate-mounted and sandwich types. The principal function of the check valves is to block oil flow in one direction—yet allow free flow of oil in the reverse direction. Both subplate and sandwich types are available in either  $\frac{3}{4}$  in. subplate or 1 $\frac{1}{4}$  in. sizes. Subplate type valves meet JIC standards, says Denison Engineering DIV., American Brake Shoe Co., Dept. S/A, 1160 Dublin Road, Columbus, Ohio.

The  $\frac{3}{4}$  in. subplate valve is available with either  $\frac{3}{4}$  in. pipe tap connection or UNF connection. The 1 $\frac{1}{4}$  in. subplate valve is available only with 1 $\frac{1}{4}$  in. pipe. The valves, according to pipe size, have the following capacities:  $\frac{3}{4}$  in.—20 gpm; 1 $\frac{1}{4}$  in.—65 gpm.

Write in No. 589 on Reader Service Card

## DAMPED MOTOR is size 11

This adjustable viscous damped size 11 motor, type 5752-05, is smaller, lighter and more economical than a motor tach used in feedback damping applications, consumes less power and presents no null or phasing problems in the feedback loop as compared with the motor tach which it replaces, says John Oster Manufacturing Co., Dept. S/A, 1 Main St., Racine, Wis.

Damping and gain may be independently adjusted. No load speed can be quickly, easily adjusted to any speed desired between 4800 and 7300 rpm depending upon damping characteristics required in the system, it is said. The unit can be built in a standard Buord Mark 14 characteristic. It meets MIL-E-5272A and has an ambient temperature range of —55 to +125 deg C.

Write in No. 590 on Reader Service Card

## ROTARY SWITCH is solenoid-operated

This new type solenoid-operated, uni-directional rotary switch, consists of six poles with 24 non-shorting positions per pole. It can be operated at temperatures up to 125 deg C and at altitudes up to 80,000 ft. The switch measures 2 $\frac{1}{4}$  in. square by nine inches in overall depth, including the solenoid, and it will withstand an acceleration of 50 g, says Daven Co., Dept. S/A, Livingston, N.J.

In this unit, connections can be made from the switch body to a phenolic terminal board on the side of the switch. In the field, connections can be made directly to the terminal board. The unit is completely enclosed in a dust cover and can be operated for over one million cycles, it is claimed.

Write in No. 591 on Reader Service Card

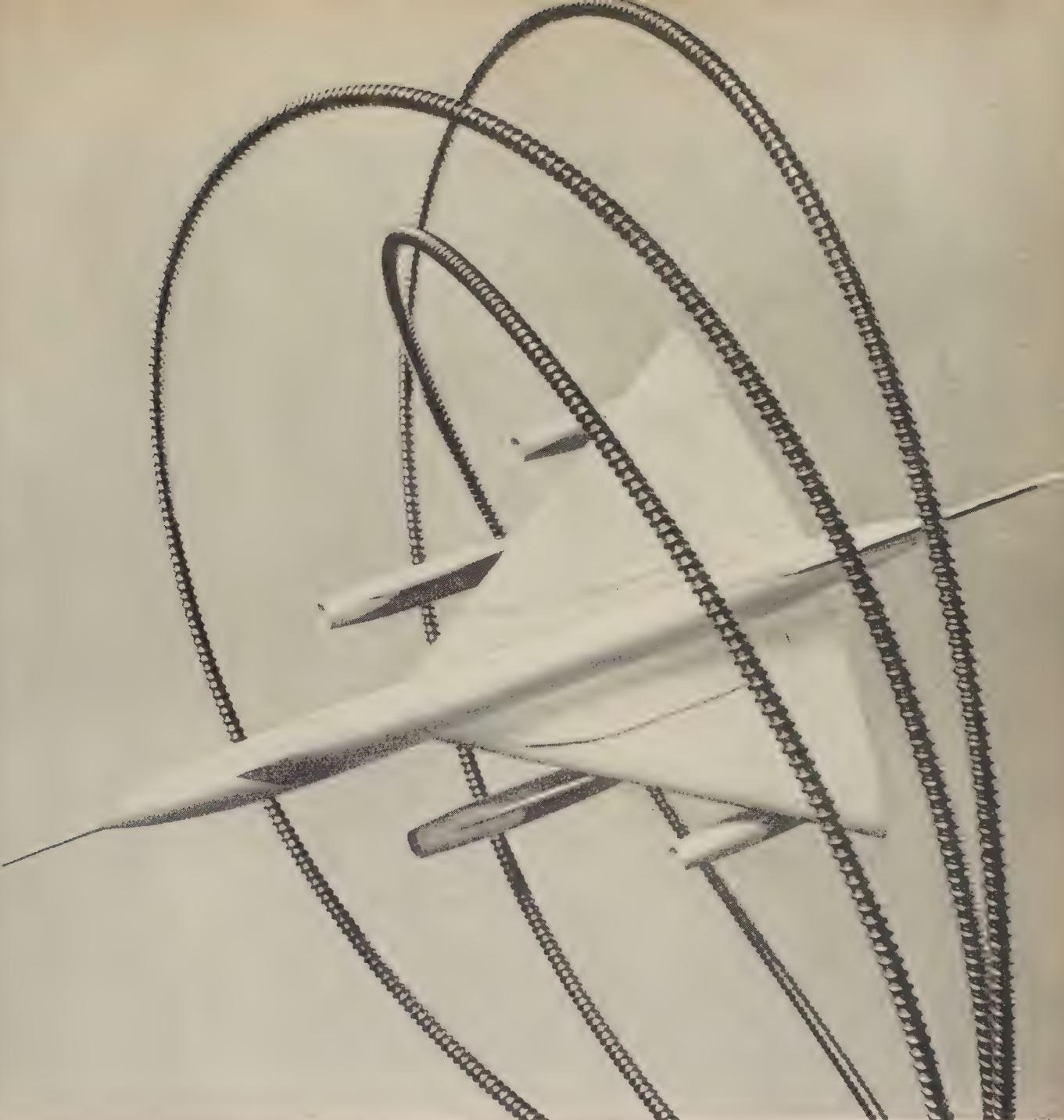
## TRANSDUCER for low flow rates

This flow rate transducer, the Mark X, senses flows as low as 0.002 gpm and translates fluid flows, at high static pressure and temperature, into a linear electrical signal. It is a miniature variable area type flow sensor in which a specially shaped body of fixed size moves in a tapered tube. The unit is corrosion resistant. Maximum working pressure is 3,500 psi, pressure drop is two psi in most ranges; maximum fluid temperature is 250 deg F, says Ramapo Instrument Co., Inc., Dept. S/A, Bloomingdale, N.J.

Flow rate accuracy of the unit is one per cent of flow rate when calibrated with operating fluid. It is two inches in diameter, 39 $\frac{1}{4}$  in. long and weighs three pounds.

Write in No. 592 on Reader Service Card  
more on page 290

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SPACE/AERONAUTICS



## How to design remote control systems that are 95% efficient in a 90° bend. Or...

. . . how to get 18000° shaft rotation with up to .00055% accuracy. Or, remotely synchronize valves in a temperature range of -100° to 1200°. Or, design around any contour or bend without intermediate links or pulleys, and cut weight of systems by 54%-60% of cable pulley or rod and bellcrank systems.

The "how" is with TELEFLEX® systems. The "why" is the exclusive TELEFLEX helix wire cable design. No remote control cable anywhere gives such high sensitivity and response . . . such a reduction in weight and backlash . . . such design freedom with straight line, angular and unlimited rotary motion!

The technical advances made possible with TELEFLEX cable mean that TELEFLEX engineers have gone further and can offer more in the development of complete mechanical control systems for any purpose. Write today for catalog, or help on your specific problem. TELEFLEX Incorporated, North Wales, Pa.

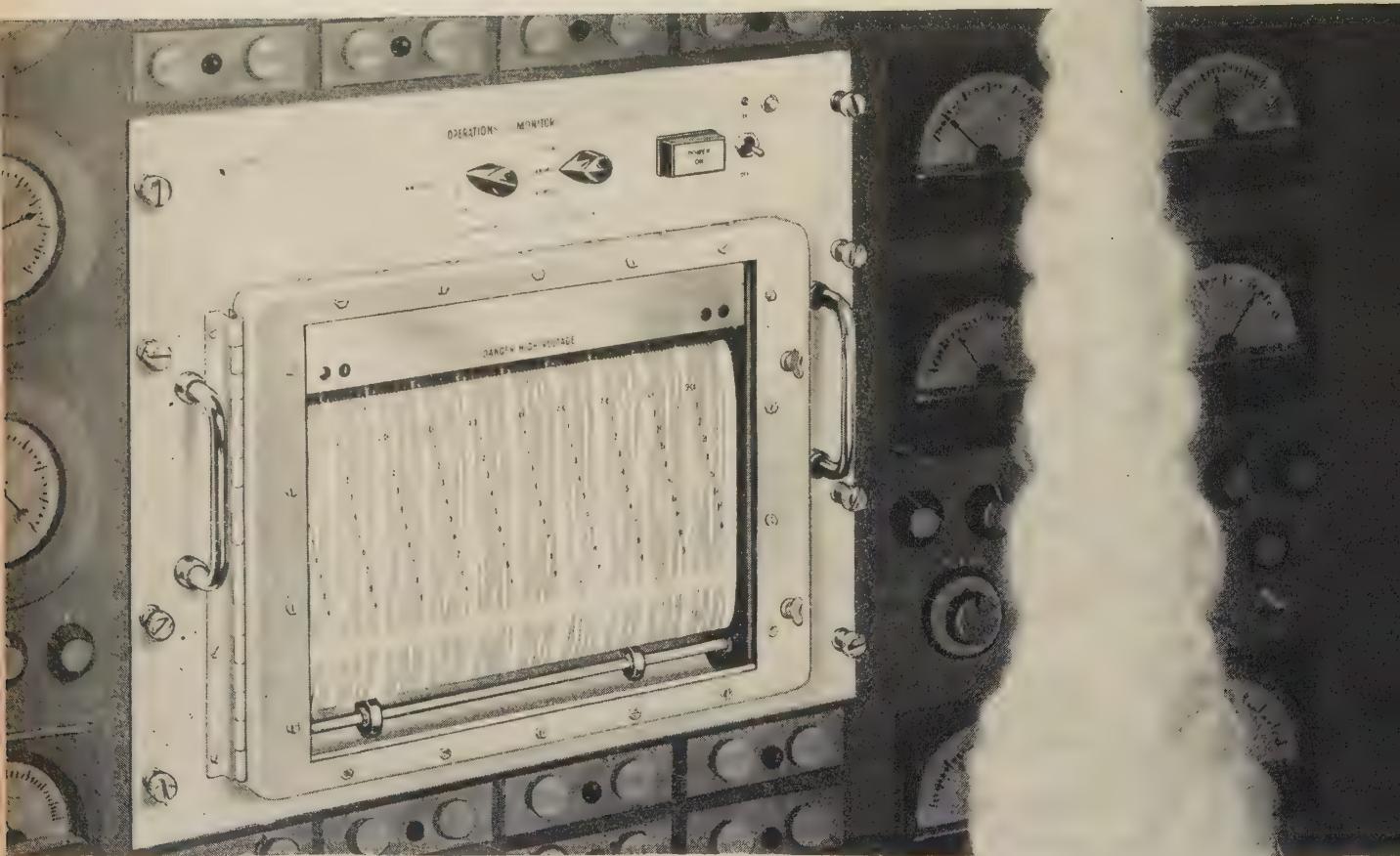
TELEFLEX SYSTEMS offer unequaled design flexibility because they are the only systems to offer all three types of mechanical motion...



**TELEFLEX**  
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**BUILT TO MIL SPECS...**

**one Brush Monitor records  
100 countdown operations  
simultaneously!**



Built to military specifications and performing to extremely rigorous military requirements, the Brush Operations Monitor can prevent aborts and destracts costing millions of dollars.

For quick, accurate and immediately visible go and no-go information, 100 operations are recorded simultaneously on a 500' moving chart only 12" wide. You have an *immediate* picture of an entire situation with each event shown in a time relationship to all other events. It is now being used for major check-out of propulsion systems, electrical test racks, fault isolation programmers and launch control vehicles.

Brush is now in production on this Mil Operations Monitor and prompt delivery can be made to your requirements. Phone or wire Brush for complete information and application assistance.

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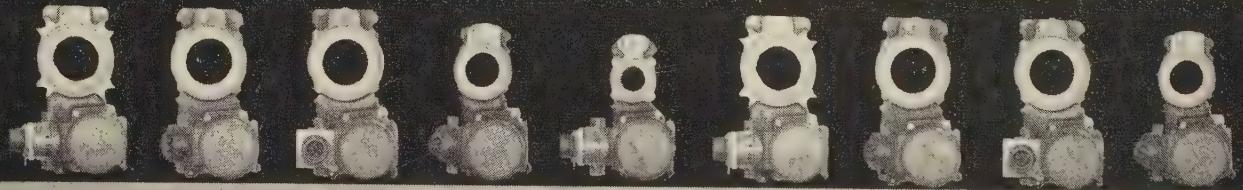
WHITTAKER



TELECOMPUTING  
CORPORATION  
LOS ANGELES



# OFF THE SHELF!



# A NEW LINE OF WHITTAKER GATE VALVES

At last... a standard gate valve that can be adapted quickly to any fuel or hydraulic system! After years of manufacturing over 1,000,000 gate valves, WHITTAKER CONTROLS now presents a complete line of standard gate valves incorporating the finest time-proven features. Whittaker pioneered and developed the much imitated concept of the one-piece mechanically loaded and retained Teflon dynamic seals. This allows satisfactory operation under the most demanding fluid characteristics and environmental conditions. Whatever your requirements in fluid controls, Whittaker can provide the answer. Note these features:

- interchangeable actuators—can be detached without removing valve from plumbing
- low-torque manual override
- rugged construction — corrosion resistant, wearproof, insensitive to temperature change
- thorough qualification testing — meets or surpasses all requirements of MIL-V-8608
- withstands up to 40-g vibration over a wide spectrum of frequencies
- immediate delivery — pre-engineered for all applications.

Write for brochure or call any of our offices for information.

*Time-proven Reliability  
In Hydraulic-Pneumatic-Fuel Controls*



**WHITTAKER CONTROLS**

DIVISION OF TELECOMPUTING  
CORPORATION

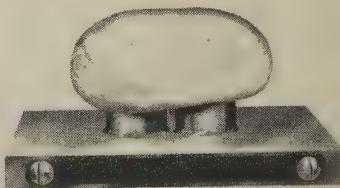
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October 1959

**JUNCTIONS**  
for control use



protect your  
circuits ...REPLACE FUSES WITH A  
**Thermocal switch**

**PYRISTOR®**...protects your  
equipment circuitry...precisely

NEW miniature, hermetically sealed, single-shot, current-sensitive switch for positive overload protection and for current operated triggering devices.

RELIABILITY in critical environments  
...from -100° F. to +1000° F. continuous.  
...closing time 1 millisecond to 5 seconds.

Write for new  
Brochure containing  
complete specifications:  
advanced concepts of  
precision specialty  
switches for maximum protection

**thernocal**  
1631 COLORADO AVENUE  
SANTA MONICA, CALIFORNIA

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290

The control of quartz crystal ovens, critical electrical circuits and other devices where relatively low heat input or extraction is involved can be handled by the TA-11 Thermo-cell, a compound semiconductor for cooling, heating, power generation and dynamic heat transfer, says Ohio Semiconductors, Inc., 1035 W. Third St., Columbus 8, O. The thermoelectric junction is designed to maintain a temperature that is either above or below the ambient.

For a two-W input, temperature differences exceed 40 deg C, and without the heat load, the cold junction temperature is -15 deg C. A frosted TA-11 thermo-cell, which can be used as a Peltier cooler, has a junction temperature of -35 deg C with a two-W input. The TA-11 devices may be combined for greater capacities by connection into series, parallel or cascade arrangements.

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**CAPTIVE STUDS**  
are flush, self-clinching

This captive stud is designed for quick, easy, flush-head installation in panels of cold rolled steel, brass, copper, aluminum alloys, and similar materials of thicknesses from .040" and up. These studs are dropped into punched or drilled holes and squeezed into place, one or several at a time, by use of standard pneumatic, hydraulic, or mechanical presses, says Penn Engineering & Mfg. Corp., Dept. S/A, Doylestown, Pa. The squeezing action embeds the head projections of the stud into the panel.

Made in steel and 305 stainless steel types in thread sizes from #4-40 to 5/16-18 and in lengths from 1/4" to 1 1/2".

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more on page 292

# Pioneering Achievements in Rocketry at JPL



**LIQUID PROPELLANT SYSTEMS**...were pioneered at JPL. Development work began in 1943 and led to the first practical rocket power-plant in the United States in which spontaneous ignition took place upon mixing of the oxidizer and fuel.



**SOLID PROPELLANT SYSTEMS**...received momentous impetus in 1947 with the successful flight of the Thunderbird, a test rocket. This JPL pioneering achievement demonstrated a new technique which has since revolutionized the field of solid propellant rockets.



**DEVELOPMENT**...of efficient rocket power plants involves large scale testing and the application of knowledge from many scientific and engineering fields—thermodynamics, combustion, heat transfer, fluid mechanics, and metallurgy.



**HEAT TRANSFER**...studies at JPL with a camera using a Kerr cell shutter taking photos at 20,000 frames per second were the first high-speed, high-resolution motion pictures successfully recording the action of nucleate boiling.



**MATERIALS RESEARCH AND TESTING**...is one of many supporting research programs under way at the Laboratory and are considered a "must", in providing needed data for engineers concerned with the design and development of propulsion systems.



**TESTING**...of rocket engines resulted in the establishment of a center for recording rocket engine measurements when in 1948 the Lab established the first system serving five engine test cells. This has now expanded to a complex multi-channel system.



CALIFORNIA INSTITUTE OF TECHNOLOGY  
**JET PROPULSION LABORATORY**  
A Research Facility operated for the National Aeronautics and Space Administration  
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STRUCTURES, CHEMISTRY, INSTRUMENTATION, MATHEMATICS, AND SOLID STATE PHYSICS

Send professional resume, with full qualifications and experience, for our immediate consideration

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# For Safe Flexible Fluid Handling Lines— specify CHIKSAN SWIVEL JOINTS



## FOR MISSILE FUELING

Swivel Joints and assemblies to handle cryogenic liquids and fuels in ground loading and topping hose. Assemblies developed to handle services ranging from  $-320^{\circ}\text{F}$  to  $+600^{\circ}\text{F}$  and pressures from 20" vacuum to 15,000 psi.



## FOR GROUND SUPPORT EQUIPMENT

Loading arms and flexible transfer assemblies for handling Lox, N<sub>2</sub>, He, JP Fuels, H<sub>2</sub>O<sub>2</sub> and Hot Gases. Sizes range from  $\frac{1}{4}^{\prime\prime}$  to  $16^{\prime\prime}$ . Corrosion resistant steel, nickel, brass, aluminum, bronze and other metals available.



## FOR GROUND HANDLING EQUIPMENT

Swivel Joints and assemblies to handle hydraulic, pneumatic, and fuel systems on launching vehicles and missile transporters. Units for rotation in 1, 2 or 3 planes in widest variety of metals, pressure and temperature available.



## FOR AIRCRAFT SYSTEMS

Compact, lightweight package units in  $\frac{1}{4}^{\prime\prime}$ ,  $\frac{3}{8}^{\prime\prime}$ ,  $\frac{1}{2}^{\prime\prime}$  and  $\frac{5}{8}^{\prime\prime}$  O.D. tubing sizes. Pressures of 28" vacuum to 4,000 psig. Temperatures of  $-65^{\circ}\text{F}$  to  $+275^{\circ}\text{F}$ . AN and MS standard end connections.

### CHIKSAN COMPANY

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION  
CHIKSAN COMPANY - BREA, CALIFORNIA



Send for  
informative  
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59-41

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## PRODUCT PREVIEW

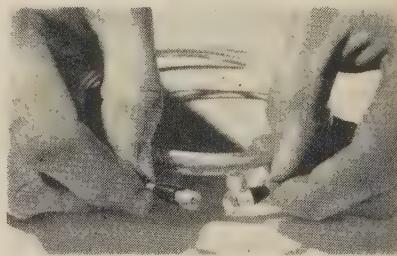
### SERVO AMPLIFIER is very small

A transistorized, sealed, low-power servo amplifier that measures about one cu in has been designed by ACF Industries, Inc., Dept. S/A, 11 Park Pl., Paramus, N.J. The high gain, high input impedance device will drive a 3.5-W servomotor from low-level ac signals.

The model 412 Series, which needs only 28-V dc excitation, is rated for a gain of 2500 plus or minus five per cent, with a ten-V output. Ambient temperature range is  $-55$  to  $+100$  deg C.

Write in No. 598 on Reader Service Card

### CRIMP-TYPE CONNECTORS are microminiature



Complete line of crimp type microminiature RF connectors match standard subminiature RG/U coaxial cables. Initial release of plugs, jacks bulkhead jacks at right angle plugs, hermetically sealed receptacles in screw-on and slide-on couplings, says Industrial Products Co., Dept. S/A, Danbury, Conn.

Standard T&B crimping tools are utilized. Series MM connectors offer many new reliability features, including a simplified cable clamp design captivated contacts and gold over silver plating.

Write in No. 599 on Reader Service Card

### PRECISION SWITCH for high temperatures

Long exposure to temperatures up to  $+800$  deg F will not affect operating characteristics of the spdt Klixon 21135-1 switch, says Texas Instruments, Inc., Dept. S/A, Attleboro, Mass. The limit or sensitive switch is designed for precision applications on aircraft and guided missiles, as well as for ovens and other high-temperature environments.

Size is said to be about  $\frac{1}{8}$  that of comparable units, and the device has a life expectancy of over 25,000 cycles at 800 deg F, with five amps on both contacts. The switching element is a one-piece sine blade that eliminates knife edges and high friction points. All components of the one oz switch are inorganic.

Write in No. 978 on Reader Service Card  
more on page 294



INERTIA SWITCH Inc.

311 West 43 Street, New York 36 • JUDSON 6-5880

Inertia Switch invites research and development inquiries in the acceleration sensing field.



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# This is the New

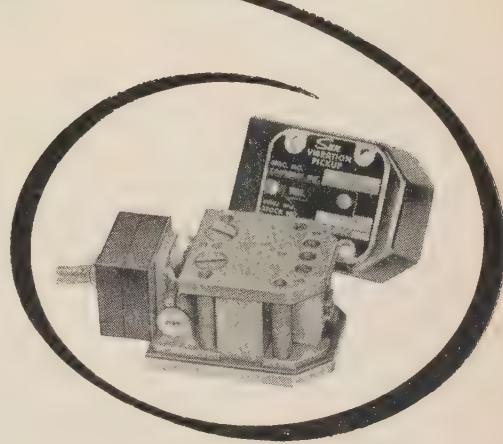
## SUN PORTABLE VIBRATION ANALYZER

U.S. NAVY BUAE  
TYPE XMA-69



Here is an entirely new concept in design and operation of an instrument to measure within a specific milli-inch range, the peak-to-peak displacement and frequency of mechanical vibrations on jet and turbo-prop engines, motors and generators.

The instrument includes four unitized designed seismic type pickups shown in the enlarged photo at right. Brief specifications appear below:



### SPECIFICATIONS

<b>Size</b>	..... 16 in. long x 12 in. wide by 9 in. high	<b>Pickups</b>	..... Velocity type with 30 ft. cables
<b>Weight</b>	..... 40 pounds	<b>Frequency</b>	
<b>Case</b>	..... Welded aluminum with hinged lid	<b>Response</b>	..... Flat 20 - 2000 cps
<b>Power Supply</b>	..... Self-contained 12v 1.7 amp/hr nickel-cadmium battery with 110v 60 cycle charging system	<b>Sensitivity</b>	..... 21.4 mv/.001 in. DA per 100 cps into a 20K ohm load
<b>Temperature Range</b>	..... -40 F to 176 F	<b>Accuracy</b>	..... Calibrated to 1%
		<b>Pickup Tem- perature Range</b>	.... -70 F to +250 F continuous
		<b>Pickup Mounting</b>	.. Omnidirectional

For Additional Details, ask for Technical Data Sheet PVA

**Sun** ELECTRIC CORPORATION  
AERONAUTICAL-INSTRUMENT DIVISION  
HARLEM AND AVONDALE • CHICAGO 31, ILLINOIS, U.S.A.

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**BOSS CONNECTOR**  
has all-metal seal

This "Invermeto" inverted nut and sleeve boss connector for aircraft and missile boss seals permits connection of tubing directly to the boss. Fitting eliminates one connector and one sealing point. The boss configuration results in a 68% fitting weight reduction of a -10 steel system, according to Weatherhead Co., Dept. S/A, 300 E. 131 St., Cleveland 8, Ohio.

Other advantages include: elimination of elastomeric seal ("O"ring) permits use of the boss at elevated temperatures and in fluid environments which would adversely affect the elastomer; fittings can be easily rotated and locked in any required position; utilization of the MS flareless fitting concept, which has been upgraded for advanced fluid systems, including cryogenics and non-flammable high tensile tubing.

Write in No. 979 on Reader Service Card

**POWER RELAY**  
is rugged

A new general purpose power relay, type U, is said to be ruggedly built with single coil construction, employing box type magnetic field. Movable contact springs are mounted on molded phenolic insulating bars, providing positive contact alignment. Contact of  $\frac{1}{4}$  in. diameter are available in either silver or silver cadmium oxide, rated singly at ten to 25 amperes, 110 V ac, non-inductive. Available contact forms 1C to 5C. Maximum contact pressures 35 grams each, says Comar Electric Co., Dept. S/A, 3349 Addison St., Chicago 12, Ill.

Dc relays incorporate use of high quality iron annealed for maximum efficiency. Ac relays have silicon iron parts, with copper shading washers.

Write in No. 980 on Reader Service Card

**SERVO MOTOR**  
is inertia-damped

This Beckman Inertia-Damped Servomotor Model 8 IM 460, is said to meet four major servo-design requirements. It weighs 2.5 oz and is 1.680 in. long. It will operate from a 115 V, 400 cycle source. It permits use of a rotor having an inertia of 0.34 gm.cm.<sup>2</sup>. Combined with a stall torque of 0.33 oz in. this produces acceleration at stall of 68,500 rad/sec<sup>2</sup>. Upper corner frequencies approaching 41 cps can be attained, says Helipot Div., Beckman Instruments, Inc., Dept. S/A, Fullerton, Calif.

This servomotor, it is said, will pass any humidity procedure or combination of procedures of MIL-E-5272A and will withstand shock loads of 100G's and vibrations of 30G's to 2,000 cycles in all major axes. Ambient temperature range is from -55 to +130 deg C.

Write in No. 981 on Reader Service Card

**HEIGHT-FINDER**  
is very accurate

The Type S244 radar height finder will provide accurate height information at the extreme radar range in early warning systems, says Marconi's Wireless Telegraph Co., Ltd., Dept. S/A, Marconi House, Chelmsford, England. The three-mw, ten-cm radar can determine the absolute height of an aircraft above ground or the relative heights of two aircraft, and it is rated for an accuracy of  $\pm 1700$  ft at 150 naut mi.

The device uses a variable vertical scan, from a datum of minus two deg to the horizontal, and an artificial horizon is incorporated. Operation is fully automatic and can be remotely controlled. Frequency is 2700 to 2900 mc, and the device uses a pulse length of five  $\mu$ sec. Repetition rate is 250 to 310 pps.

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more on page 296

# REPUBLIC VALVES

FOR EVERY INDUSTRY

## EXTRA HIGH PRESSURE FINE METERING

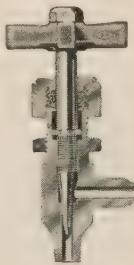
### HIGH PRESSURE NEEDLE VALVE



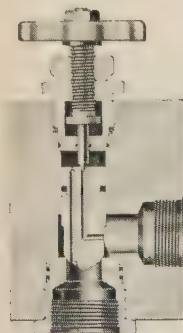
10,000 psi hydraulic service. Forged stainless steel one-piece body. Panel mounting. Good flow characteristics, fine metering, easy to turn. Water, gas, oil and vacuum service,  $\frac{1}{8}$ " to  $\frac{1}{2}$ " pipe or straight thread tube connections.

### MICROMETER ADJUSTMENT NEEDLE VALVE

Best for extra fine metering. Micrometer adjustment, precision taper stem. 5000 psi service -65° to 350°F., oil, water, etc. Brass, aluminum alloy, steel, or stainless steel body.  $\frac{1}{8}$ " and  $\frac{1}{4}$ " sizes. Premolded or O-ring packing. Panel mounting.



### 5000 psi THROTTLE-FLO VALVE



Accurate throttling up to 5000 psi. Finger tip control. Pilot operation of large dynamically balanced piston. Full flow, yet accurate to 1/100 gpm through entire range. Positive seal. Low pressure drop. Aluminum alloy,  $\frac{1}{2}$ ",  $\frac{3}{4}$ ", 1" internal straight thread connections. Hydraulic seals — others available.



### HYDRAULIC BLEEDERS

Primarily used for bleeding air from hydraulic systems, for working pressures to 3000 psi at temperatures from -65° to 180°F.

Fluid control valves of many types have been developed and are manufactured by REPUBLIC. A wide line of quality standard valves includes needle, globe, check, plug, selector and relief valves, as well as other units for industrial, chemical, aircraft, missile and ground handling equipment.

Specialists in valving and manifold design to meet your specific application. Write for catalog.

Distributors in principal cities coast to coast



**REPUBLIC MANUFACTURING CO.**

15655 BROOKPARK ROAD • CLEVELAND 35, OHIO  
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**Boeing 707  
flies like a bullet  
— handles easily  
with Tiger Brand  
Control Cables**

Six miles up, the Boeing 707 carries 160 passengers more than 600 miles an hour. She's fast, comfortable and safe because the control cables were designed by American Steel & Wire to meet the most rigid specifications. These cables have high strength, high resistance to bending fatigue, minimum stretch and maximum flexibility.

Tiger Brand Control Cables are used on all types of aircraft, from small commercial planes to the heaviest bombers. There is the *right* control cable for you.

For more information write to American Steel & Wire, Dept. 9231, 614 Superior Avenue, N.W., Cleveland 13, Ohio.

*USS and Tiger Brand are registered trademarks*



**American Steel & Wire  
Division of  
United States Steel**



Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors  
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United States Steel Export Company, Distributors Abroad

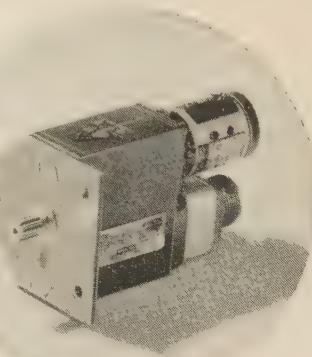
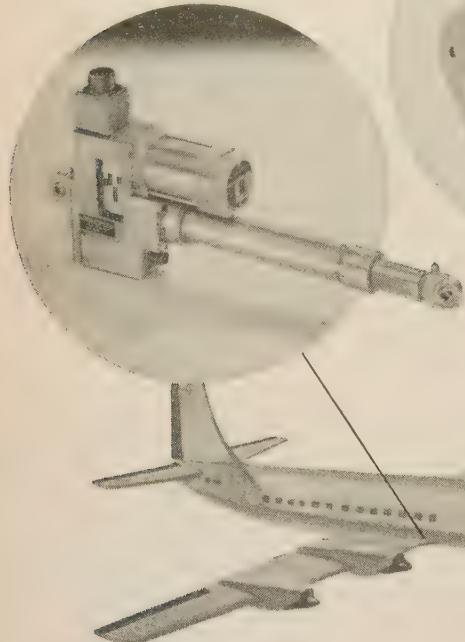
**Why Tiger Brand Control Cables are your best buy**

1. They are made by a company that maintains the most complete wire rope research and manufacturing facilities in the country.
2. They are designed by one of the country's most capable staffs of wire rope engineers. They are serviced by thoroughly experienced field representatives always ready with their assistance.
3. Every type of Tiger Brand Control Cable is designed for specific applications. You get the *right* cable for the job.
4. They are made by *one* company, U. S. Steel, and every step of production, from ore to finished product, is carefully controlled and supervised to guarantee *one* high standard of quality.
5. Tiger Brand Control Cables are manufactured by the largest single producer in the country.

**Write in No. 194 on Reader Service Card at start of Product Preview Section**

# AIRBORNE MODULAR DESIGN ACTUATORS SPECIFIED FOR ELECTRA CABIN SYSTEMS

Airborne LA16-2-2 LINEATOR modular actuator opens and closes intake door of cabin air conditioning system.



With Airborne modular actuators, you are no longer limited to a few standard models whose design is relatively fixed. Instead you can specify any one of several hundred possible combinations of interchangeable parts to get exactly the capacity and configuration you want. This gives you greater design freedom without the cost and delay of specials.

While redesigning under the modular concept, we have also reduced the size and increased the performance of many Airborne actuator components. You get more power in a smaller package, save valuable weight and space.

For full information on Airborne modular design electromechanical actuators, request Bulletin 57A (linear type) or Bulletin MR-58 (rotary).

See Airborne's new modular control systems at the Aircraft Electrical Show in Los Angeles

## PRODUCT PREVIEW

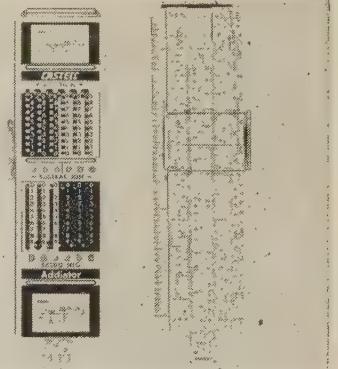
### POTTING COMPOUNDS are color coded

Positive identification of encapsulated and potted materials can be achieved with the PA-407 color-coded silicone rubber compounds made by Plastic Associates, Dept. S/A, 185 Mountain Rd., Laguna Beach, Calif. The material, available in a variety of colors, plus white, comes in kits containing three oz of color-mixed compound plus catalyst.

It sets up to rubber in about 25 min at room temperature. Fully cured, the material protects against mechanical shock and vibration and can withstand long and continuous exposure over a wide temperature range. It is also water repellent, resists corrosive atmospheres, salt water and dilute acids and alkalies, and maintains its characteristics under humid conditions.

Write in No. 983 on Reader Service Card

### POCKET CALCULATOR is versatile



This pocket sized calculator combines a 13-scale log slide rule on one side with the smallest precision adding machine on the other, says Harrison Home Products Corp., Dept. S/A, 565 5th Ave., New York 17, N.Y.

The slide rule has a 5 in. scale length and makes lightning fast computations of proportions, squares, and square roots, cubes and cube roots, multiplication, division, tables trigonometric log calculations, compound multiplication, and division.

Write in No. 984 on Reader Service Card

### SERVO AMPLIFIER is inherently stabilized

A 3.5-W Mark XIV or equivalent-size motor can be driven from low-level ac signals by the Model 403 Trans-Mag servo amplifier says ACF Industries, Inc., Dept. S/A, 11 Park Pl., Paramus, N.J. Servo stabilization is inherent in the design of the compact, self-contained unit.

Models are available with an input impedance of 30,000 ohms and a gain of 2000 or an impedance of 500,000 ohms and a gain of 900. Power requirement is 115 V, 40 cycles.

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# AIRBORNE

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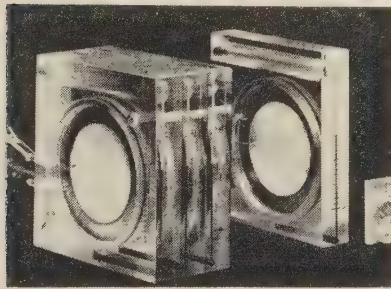
**CIRCUIT ASSEMBLIES  
wt production errors**

Benefits derived by manufacturers from Circuit-Paks include simplification of equipment assembly, a reduction in production errors, and increased reliability, says Raytheon Mfg. Co., Dept. S/A, 215 First Ave., Needham Heights 94, Mass. Circuit-Paks are assemblies containing semiconductor devices and other components connected to provide the desired circuit.

Among the assemblies available are bridge rectifiers, phase comparators, diode switches, amplifiers, and flip-flops. The final assembly is said to be compact, lightweight, easy to use, and free from atmospheric effects.

Write in No. 986 on Reader Service Card

**VOLTMETER  
uses ceramic disks**



A voltage meter that uses electrostrictive ceramic disks as the dynamic moving element has been designed by Electric Machinery Mfg. Co., Dept. S/A, 2100 E. 27th St., Vernon, Calif. The motor consists of a transparent block enclosing two opposing metal disks on which ceramic disks, coated with silver frit, are bonded.

The ceramic contracts when an electrical potential is applied, and the resulting cupping action of the metal disc forces colored fluid up a capillary tube, thus providing a visual indication of the voltage being measured. The prototype models are less than  $\frac{3}{4}$ -in wide, and even smaller models can be built.

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**RELIEF VALVE  
offers stable control**

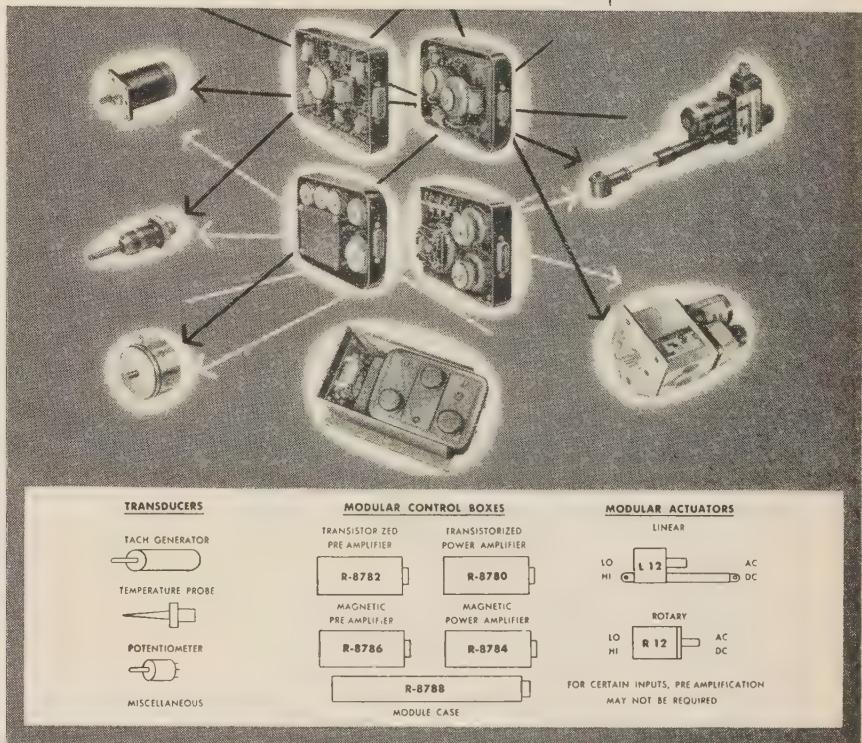
This SF-1 relief valve held its design control of  $3.0 \pm 2$ -psia range after three days of continuous testing with liquid SF-1 at  $-430$  deg F and gaseous SF at  $-220$  deg F, says Parker Aircraft Co., 5827 W. Century Blvd., Los Angeles 45, Calif. The valve, useful in aircraft and missile fuel systems, operates in ambient temperatures to  $250$  deg F and can be modified for  $500$  deg F service.

Both gage pressure control and absolute pressure control units have been built in line sizes up to three in id.

Write in No. 988 on Reader Service Card  
more on page 300

# Now - Modular Control Systems

New Airborne concept saves design time, helps you get faster delivery



Heart of Airborne's new modular control systems is a contactless control package consisting of a standardized case ( $3 \times 3\frac{1}{2} \times 5$  in.) into which packaged preamplifier and power amplifier subsystems are plugged. Amplifiers drive actuators having maximum operating loads up to 500 lb. (linear) or 100 in.-lb. (rotary). Modular design permits delivery of relatively complex systems in minimum time.

Over the past 6 years, Airborne has designed and produced a number of special electromechanical control systems for aircraft-missile use. While these have differed in their functions, many of them have nevertheless employed essentially similar components. Thus our policy has been to seek increasing standardization of parts through modular design—to the point where we can now offer complete systems engineered under this concept.

From transducer through actuator, these new Airborne systems are assembled entirely from standardized, interchangeable components. For many applications, you can de-

sign around these packaged systems as they stand—and thus reduce engineering time, lead time, and costs. In other instances, slight modifications of the modular units provide the basis for immediately available systems.

Get complete information on this latest Airborne development by requesting new Bulletin PS-5A. If you feel your requirements are unique and cannot be met with standardized units—however flexible—we still invite your inquiry. As mentioned, Airborne offers an extensive background in custom systems—for temperature control, servo control, and positioning.

See Airborne's new modular control systems at the Aircraft Electrical Show in Los Angeles

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Engineered Equipment for Aircraft and Industry

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# ALCOA AND BRUSH CREATE THE WORLD'S LARGEST BERYLLIUM FORGING TO BRING BACK THE MOST PRICELESS THING IN SPACE

ONE DAY, you'll know his name. You'll see it in the big, pulse-quickenning headlines: The man in NASA's "Project Mercury" capsule, flung into orbit on a spiral of fire . . .

AND, SUDDENLY, his life will become the most priceless thing in the black void that rings the earth. To bring him back, living, safe, unharmed—through the buffeting shock waves of the ionosphere; through the fiery heat of re-entry—this, so far, will be man's highest material achievement.

TO BRING him back safely, Alcoa has forged, on the gigantic 50,000-ton Air Force press at our Cleveland Works, the largest beryllium die forging ever turned out for *any* purpose. This forging, produced for

The Brush Beryllium Co. from their CMV hot pressed blanks, is a disk-shaped shield with an arc of 80 in. and a chord of 72 in.

THIS BERYLLIUM forging is designed to be the base of a McDonnell Aircraft Corp. "Mercury" capsule. Beryllium is used partly to reduce weight, partly to withstand the shock of re-entry . . . but primarily to absorb, diffuse and dissipate the enormous heat of atmospheric friction—permitting the interior temperature of the space capsule to rise no higher than a safe, maximum 150°F.

ARE YOU mildly amazed to find *Alcoa* forging *beryllium*? You shouldn't be. For *Alcoa* possesses the nation's largest fabricating facilities along with certain know-how

which qualifies it fully for precision fabricating *any* lightweight metal.

FOR THE SOLUTION of your sophisticated metal-working problems—in beryllium, aluminum or what have you—*Alcoa* offers, in fact, facilities superior to *any* others, anywhere. For further information, please contact your nearest *Alcoa* sales office, or write: Aluminum Company of America, 2027-K *Alcoa* Building, Pittsburgh 19, Pa.

*Your Guide to the Best in Aluminum Value*

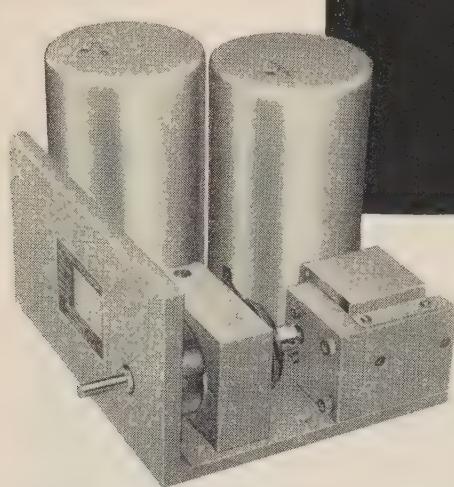


For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and the Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV

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Enlarged photograph of raw crystal



## BULOVA CRYSTAL CONTROLLED ULTRA-STABLE SHIFT OSCILLATORS

Bulova shift oscillators are all that any electronics engineer could ask for in miniature crystal controlled packages!

Consider this new Bulova custom designed 18.5mc shift oscillator. Here's an assembly of two oscillators operating at 18.5mc. One is fixed, with a 1 pp  $10^7$  stability. The other is a variable with equal stability, 1 pp  $10^7$ . The shift is accomplished by means of a variable air capacitor. How-

ever, the same shift, at the same frequency, can be affected with a varicap.

This new ultra-stable shift oscillator is only one of many recent advances made by Bulova Electronics. For information on these specific units, or on how Bulova experience, in mastering component and system reliability, can help your program, write—

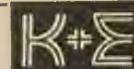
Department A-1361, Electronics Division, Bulova, 40-06 62nd Street, Woodside 77, New York



# BULOVA

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# Some Ideas



for your file of practical information on drafting  
and reproduction from

**KEUFFEL & ESSER CO.**

Frankly, we hope you're a fusspot. If you are fussy about the way you work, and proud of it, we think you'll enjoy knowing about three K&E items which reduce the effort required to get pin-neat results. Our first suggestion is ...

## A Better "Mattress" for Your Drawing Board

For effortless drafting, a good board cover is about as important as a good mattress is for sound sleep. Which is why so many draftsmen swear by LAMINENE® (N 70), the only laminated board cover material made. An exclusive, patented K&E process gives LAMINENE several very practical advantages over plastic coated papers. You can stretch it, drumhead-tight, over your board. All you do is wet the back, then secure the ends by taping or stapling to the underside of the board. After drying, LAMINENE grips the board as if cemented—there's no rippling, no stretching with the weather, no slack to take up. Its "drafting feel" is perfect: just the right balance of firmness and resiliency. LAMINENE's non-glare surface makes it easier on the eyes, too, even under fluorescent lighting. You can expect to leave the board feeling fresher, even after a long day.

What's more, LAMINENE won't crack or scar like a plastic coating. Its laminated



film surface is flexible, and stays that way—no crevices form to pick up workaday grime. It's easier to clean, too. A little soap and water is all it takes to keep LAMINENE looking like new.

LAMINENE is available in White or Eye-Ease Green; plain or with 4 x 4, 8 x 8 and 10 x 10 grids to the inch, which act as permanent two-way tracing guides. A free sample can be yours in a few days if you write us today. If you've never tried a laminated board cover, we promise you a new experience!

## Stickers With Delayed Action

Want to eliminate a time-consuming chore? You can cut down on tedious repetitive lettering by having title blocks, specifications, and other symbols or legends printed



—clearly and sharply—on DULSEAL™ (74). This tissue-thin film has a delayed-action adhesive on the back, and a dull-finish face for easy writing or printing. Stickers made of Dulseal can be firmly positioned—and re-positioned hours later, just as firmly. The adhesive takes 24 hours to set. Once it does set, a permanent bond is formed with the paper or cloth beneath. Dulseal is chemically stable, and the adhesive will not bleed, even in hot copying machines.

Repeated erasures on Dulseal will not affect its "take." Produced by an exclusive process, the "tooth" is built into the surface. Transparent and low in reflectivity,

Dulseal stickers will not affect the transparency or printing speed of your drafting medium. K&E supplies Dulseal in sheets, rolls (printed to your specifications if you wish), and as a mending tape in a handy dispenser. Try a sample, on us!

## 3 To Keep Clean

Best way to keep your tracings clean: don't let them get dirty. A mighty easy way to achieve this is to sprinkle the tracing lightly with gum eraser particles, while working. Then, triangles, T-squares, and scales stay clean, and clean the surface automatically, as they are moved back and forth. The particles will not dry out or harden—they contain no grit or abrasives. They'll actually improve the ink taking qualities of your drafting surface.



For this purpose, K&E supplies cleaning particles put up in three different ways. We think the new plastic squeeze-bottle (3036C) is the handiest of all. The shaker-top can (3036) has also been a drafting-room favorite for some time. And, for double-duty cleaning, we suggest the ABC Dry-Clean Pad™ (3037), which holds slightly coarser granules that sift through soft mesh. The ABC Pad also comes in handy for wiping a complete tracing after it is finished, or for preparing certain surfaces for ink work. Or for an overall pre-cleaning, since the best way to insure clean tracings is never to let soil build up.

The proverbial ounce of prevention is worth the traditional pound of cure!

These K&E products, and others  
that can make life easier for you,  
are available from your nearby  
K&E dealer. See him soon . . .  
or send us the coupon below for  
further information and samples.

**KEUFFEL & ESSER CO., Dept. AA-10, Hoboken, N. J.**

Please send me samples of LAMINENE® Drawing Board Surface Material,  
and DULSEAL™ Tape . . . plus information on K&E cleaning powders.

Name & Title \_\_\_\_\_

Company & Address \_\_\_\_\_

2002

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SPACE/AERONAUTICS

# Materials Memo

3M reports on high temperature coolants . . . aerospace film . . . and microfilm reader-printers

**■ CONCERNING NUCLEATE BOILING:** 3M's CHEMICAL DIVISION—and its customers—are entranced by the performance of the inert fluorochemical liquids as high temperature coolants. The compact size of the Martin Co. amplifier, illustrated here, is one result.

This significant size reduction is due to FC-75's excellent electrical properties and its unusual heat transfer characteristics.

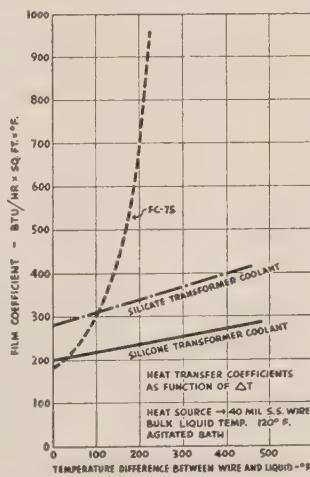
On the one hand, we can rattle off these statistics:

dielectric strength of 35 KV for liquid or vapor; dielectric constant 1.8; dissipation factor 0.0005; completely inert and unreactive with all ordinary materials of construction; non-flammable.

But it's the heat transfer characteristics that become fascinating. FC-75 has a boiling point of 214°F and is stable for continuous duty up to 800°F. Laboratory studies of heat transfer fluids in electrical equipment show FC-75 to be superior because it transfers heat by nucleate boiling at relatively low temperatures. Conventional heat transfer coolants transfer heat by natural or forced convection. And (as we all remember from college heat transfer courses) boiling film coefficients are usually higher than convection film coefficients. Some recent lab data on the subject are shown in the graph.

The FC inert liquids are doing extremely well in electrical applications. With all the heat problems in missile systems, we can't help but wonder if there aren't other places where these unusual physical properties could help you.

**■ AEROSPACE FILM:** "Scotchpak" Heat-Sealable Polyester Film was developed as a packaging film, primarily. It's doing a good job there . . . being used for "boil-in-the-package" frozen foods, for packaging oils, greases, paints, machine parts.



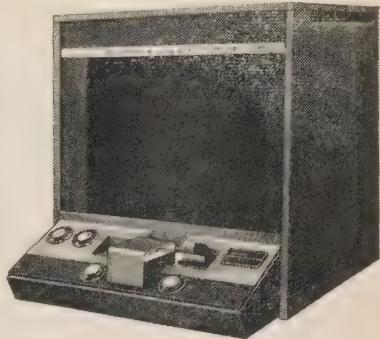
A unique material like this finds many interesting applications in aerospace industries. It rides high in the sky as a balloon for weather or research work. It forms an excellent air-inflated structure. Sanders Associates bonds it to copper foil to form a flexible printed circuit. They also use it to cover etched printed circuits for protection.

Another group has investigated it as a temporary shelter for space travelers. Being extremely light weight, strong, and tough, it might be inflated for a temporary structure on the surface of the moon or some other equally barren spot.

Samples or literature? Contact your 3M Industrial Trades Tape converter salesman, or write the address below.

**■ ENGINEERING PRINTS IN SECONDS:** The use of microfilm for engineering drawings, a growing trend in the missile industry, promises greater speed, efficiency and economy in engineering departments.

And now a new product of 3M research . . . the THERMO-FAX "Filmac 200" Reader-Printer . . . makes microfilm practical for large and small companies alike. For this "Filmac 200" Reader-Printer makes enlarged prints — up to 18 x 24 inches — from microfilm automatically, in seconds.



Engineers like microfilm systems when copies are as easy to use as the original tracings, when prints can be made at the touch of a button. And the price of the "Filmac 200" Reader-Printer also makes it attractive to missile companies of all sizes. It's just \$919.

Call your dealer for THERMO-FAX Microfilm Products for full information or write 3M at the address below.

**■ WHAT'S "MIL"?** 3M's Missile Industry Liaison is a service staff of technical personnel experienced in rocket propulsion and other phases of space technology. Their job is to translate problems of the aerospace industry to those 3M specialists best qualified to solve them. For information on products mentioned here, or other 3M products for your needs, write 3M Company, Missile Industry Liaison, Dept. VAA109, St. Paul 6, Minnesota.

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Immediate openings for vibration, flutter, and dynamic analysis engineers to work on the most advanced weapon systems — such as the B-70, the F-108, and the X-15, first manned space ship.

A background in AE, ME, or other applicable experience is necessary. Qualified vibration engineers will calculate and measure vibration levels for consulting on procedures to insure crew comfort and work out vibration environment problems on equipment of particular airframes. The flutter and dynamic analysis engineers will evaluate flutter characteristics, including servo systems, of particular airframes by analytical techniques and by the use of dynamic models, and conduct other studies relating to gust penetration, landing, and taxi conditions.

For more information please write to: Mr. P. K. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF

**NORTH  
AMERICAN  
AVIATION, INC.**



Check Employment Inquiry Form on Page 233  
302

## PRODUCT PREVIEW

### PRESSURE REGULATOR has high response

High dynamic response of better than 0.09 sec coupled with precise pressure control is featured in this large capacity, light weight gas pressure regulator. Straight through flow design with single-stage reduction permits flow rates at pressure differentials as low as 50 psi, says Reaction Motors Div., Dept. S/A, Denville, N.J.

One unit operates at  $300 \pm 3$  psi, over an inlet pressure range from 3000 to 400 psi and a flow demand change of 140 to 640 scfm of nitrogen. It weighs  $4\frac{1}{2}$  lb and its maximum dimension is  $6\frac{1}{2}$  in. It meets the missile vibration specifications and will operate between  $-65$  and  $+225$  deg F.

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### S-BAND BEACON is lightweight



The outstanding features of the Model 19SC S-band beacon include exceptionally small size and light weight, according to Telerad Mfg. Corp., Dept S/A, 1440 Broadway, New York 18, N.Y. The receiver-transmitter is  $6\frac{1}{4} \times 2\frac{1}{2}$  in dia., and the power supply is  $5 \times 2\frac{1}{2}$  in dia: each unit weighs two lbs.

Frequency range is 2850 to 2950 mc, stability is  $\pm$  two mc, and triggering sensitivity is  $-40$  dbm. The rugged device, which withstands high shock and acceleration, has a power supply input of  $6.5$  V  $\pm 0.5$  vdc at 2.5 amps, and a 150 vdc output.

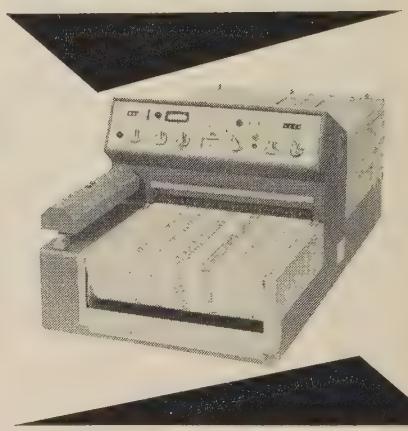
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### SMALL AMPLIFIER for strain gage signals

The Model CA9 airborne strain gage signal amplifier system offers a reduction in system complexity while saving space and weight, says Statham Instruments, Inc., Dept. S/A, 12401 W. Olympic Blvd., Los Angeles 64, Calif. A single package combines both power source for excitation and the signal amplifier, which has self-contained balance and gain controls.

Frequency response is zero to 2000 cycles, and regulation is internal. The device operates from 28 vdc and has a zero to five vdc output. It will withstand the effects of a wide ambient temperature range, and high shock and vibration.

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more on page 302



**603/607**

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50 TRACES — 12" RECORD — 20 RECORD SPEEDS (.071 TO 173 IPS) — 6,000 CPS FLAT RESPONSE — REVERSING RECORD.

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ALSO MANUFACTURERS OF  MAGNECORD  
FINE TAPE RECORDING INSTRUMENTS

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SPACE/AERONAUTICS

# DELCO RADIO

## POWER TRANSISTORS

Unsurpassed Performance, Widest Applications,  
Military Types



Delco Radio has a complete line of  
germanium power transistors

HIGH POWER—The conservatively rated 15 ampere stud-mount series leads the field with improved collector to emitter voltages, low saturation resistances, and diode voltage ratings measured at 85°C. The JAN 2N174, MIL-T-19500/13A, and the commercial 2N174 are leaders in the switching versions of this series. Headed by the 2N1100 and including the new 2N1412, other transistors in the Delco Radio high power family have equally impressive performance characteristics.

MEDIUM POWER—The new 5-ampere series in the JEDEC TO3 case includes the 2N1168 and 2N392 for high power gain in low distortion linear applications. The 2N1011 (MIL-T-19500/67 Sig.C), 2N1159, and 2N1160 for higher voltage switching applications complete this series. • The low diode leakage 2N553 series, also in the JEDEC TO3 case, is rated up to 4 amperes. Usage of this series is growing rapidly in a variety of applications—especially in regulators. The 2N297A (MIL-T-19500/56 Sig.C) and the 2N665 (MIL-T-19500/38 Sig.C) are produced from this type, making with the above a comprehensive line for military applications.



### MINIATURIZED MIGHT—

The new 2N1172 is a mighty mite for a wide variety of usages where the modified JEDEC 30 package, on a functioning miniature diamond base, permits dissipation up to two watts at 70°C.



Write today for engineering data or personal applications assistance in getting these readily available, proved transistors to work in your most exacting requirements.

# DELCO RADIO

DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA  
BRANCH OFFICES

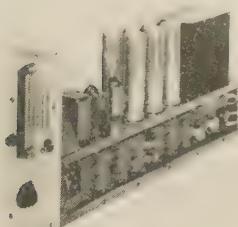
Newark, New Jersey  
1180 Raymond Boulevard  
Tel: Mitchell 2-6165

Chicago, Illinois  
5750 West 51st Street  
Tel: Portsmouth 7-3500

Santa Monica, California  
726 Santa Monica Boulevard  
Tel: Exbrook 3-1465

Write in No. 565 on Reader Service Card at start of Product Preview Section

**TRANSISTOR AMPLIFIER**  
for wideband use



Exceptional linearity in phase and amplitude characteristics is featured by this all-transistor instrumentation amplifier, says Dynamics Instrumentation Co., Dept. S/A, 1118 Mission St., South Pasadena, Calif. The model 1634 has an integral power supply and offers voltage gains from one to 100 with 100 k input impedance.

The low noise (50 uv or less) device has a frequency response of two cps to 100 kc,  $\pm 0.5$  db, for full compatibility with other elements of modern instrumentation systems. Response is minus three db from 0.4 cps to 200 kc. The amplifier will drive cables with ratings up to 2000 mmf to 50,000 cps without signal distortion.

Write in No. 992 on Reader Service Card

**HOOK-UP WIRE**  
for high temperatures

Three types of extruded polyvinyl chloride hook-up wire, which conform to Navy spec Mil-W-16878 B, are being produced for high temperature applications by American Super-Temperature Wires, Inc., Dept. S/A, 2 W. Canal St., Winooski, Vt. Temperature rating is  $-55$  to  $+105$  deg C for continuous operation.

Wire Types B, C and D are rated at 600, 1000, and 3000 V, respectively. Available sizes are: AWG 32 through 16 for Type B; 24 through 14 for Type C; and 24 through Six for Type D. The wire is available with nylon jackets, vinyl jackets, and shielding. Conductors are soft-tinned copper wire.

Write in No. 993 on Reader Service Card

**RELAY**  
meets high shock test



Shock tests of 100 g's for 11 msec do not impair operation of a new current-sensitive relay in the Powrmitre microminiature relay series, says Fil-tors, Inc., Dept. S/A, Port Washington, N. Y. The S Type relay also withstands vibration tests of ten to 55 cps at .06 double amplitude and 55 to 2000 cps at 30 g's.

The dpdt relay has a contact rating of two amps resistive, pull-in time of five msec maximum, and an identical drop-out time. Standard coil resistance values range from 185 to 10,000 ohms.

Write in No. 994 on Reader Service Card

**DIGITAL CIRCUIT**  
in one-mc series

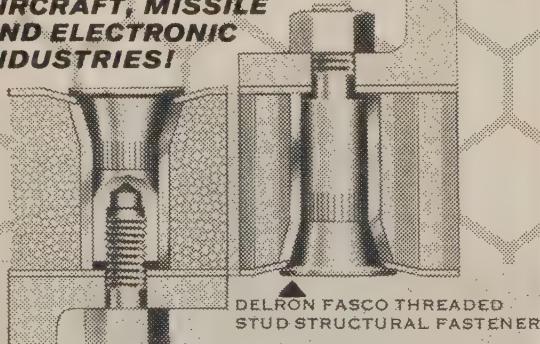
The Series 1000, a complete family of one-mc units, has been added to the transistor digital circuits made by Epsco, Inc., Dept. S/A, 588 Commonwealth Ave., Boston, Mass. They join the Series 100 TDC's suitable for operation to 200 kc, which made possible efficient and economical engineering of logical portions of any digital system.

The plug-in units, encompassing all required digital circuits in various combinations, are fully compatible, compactly designed, and fully encapsulated, as well as low in cost.

Write in No. 995 on Reader Service Card  
more on page 306

**HONEYCOMB**  
and sandwich panel  
FASCO  
**FASTENERS**  
by *Delron*

AIRCRAFT, MISSILE  
AND ELECTRONIC  
INDUSTRIES!



Illustrated above are two of the many new Delron structural design fasteners now available for Honeycomb and Sandwich Panels.  
• Write for engineering data.

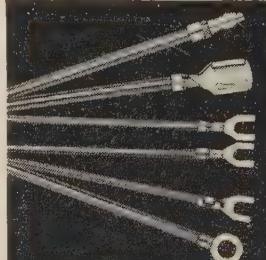


... Largest manufacturer  
of specialized Sandwich  
Panel Fasteners.

THE DELRON COMPANY, INC.

5224 Southern Avenue, South Gate, California  
LOrain 7-2477

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DO YOU NEED  
AUTOMATION  
for  
FINISHED WIRE LEADS  
with  
Terminals Attached?

**NEW ARTOS TA-20-S**  
Performs 4 Operations Automatically!

1. Measures and cuts solid or stranded wire 2" to 250" in length.
2. Strips one or both ends of wire from  $1/8$ " to 1".
3. Attaches any prefabricated terminal in strip form to one end of wire. (Model CS-9-AT attaches terminals to BOTH ENDS OF WIRE simultaneously.)
4. Marks finished wire leads with code numbers and letters (optional attachment).

**UP TO 3,000**

finished pieces per hour. Can be operated by unskilled labor. Easily set up and adjusted to different lengths of wire and stripping. ENGINEERING consultation without obligation. Machines for all types of wire lead finishing.

AGENTS  
THROUGHOUT THE  
WORLD



WRITE for FREE Bulletin No. 655 on Artos TA-20-S

**ARTOS** ENGINEERING CO.

2773 South 28th Street

• Milwaukee 46, Wisconsin

Write in No. 567 on Reader Service Card

Check Employment Inquiry Form on Page 233 →

# These R&D Projects for Future Decades in Space

*typify Lockheed's vast program of Air/Space Science*

■ New programs and study contracts awarded to Lockheed's California Division are planned to solve America's future exploration projects into space. The new multimillion-dollar Research Center in nearby San Gabriel mountains is further evidence of Lockheed's determination to support and supplement its already extensive research and development activities.

As a result of this markedly expanded program, there is urgent need for engineering and scientific personnel with high-level technical skills.

Long a leader in advancing the science of flight, Lockheed is placing vast resources and accumulated knowledge into programs designed to provide major break-throughs in the fields of: Basic and applied research; manned aircraft of advanced design; missiles and spacecraft. Some of these important research and development programs are:

**High Altitude Flight Vehicles** with speed ranges

between Mach 8 to 25. Problems associated with landing **Manned Space Vehicles** capable of hypersonic glide or orbit about the earth. **Infrared System** studies as an advanced method of detecting ultrasonic missiles and high-speed aircraft. **Solar Radiation** studies. **Vertical Take-Off and Landing** and "air recovery" vehicles. **Helicopters. Supersonic Transports.**

High caliber scientists and engineers are invited to investigate Lockheed's outstanding career opportunities. Openings now exist in: Aero-thermodynamics; propulsion; armament; electronics—research and systems; servomechanisms—flight controls; sound and vibration; operations research; physics; antenna and telemetry; and underwater sound propagation.

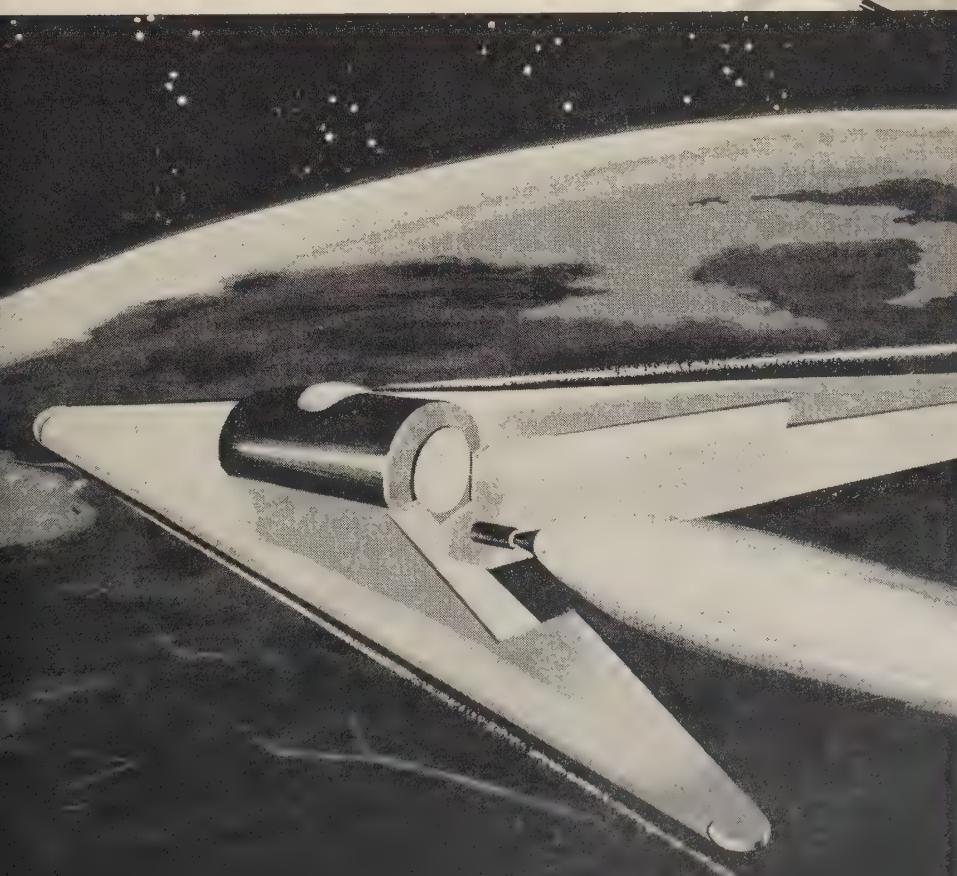
Write today to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1910, 2400 North Hollywood Way, Burbank, California.

# LOCKHEED

CALIFORNIA DIVISION  
BURBANK, CALIFORNIA



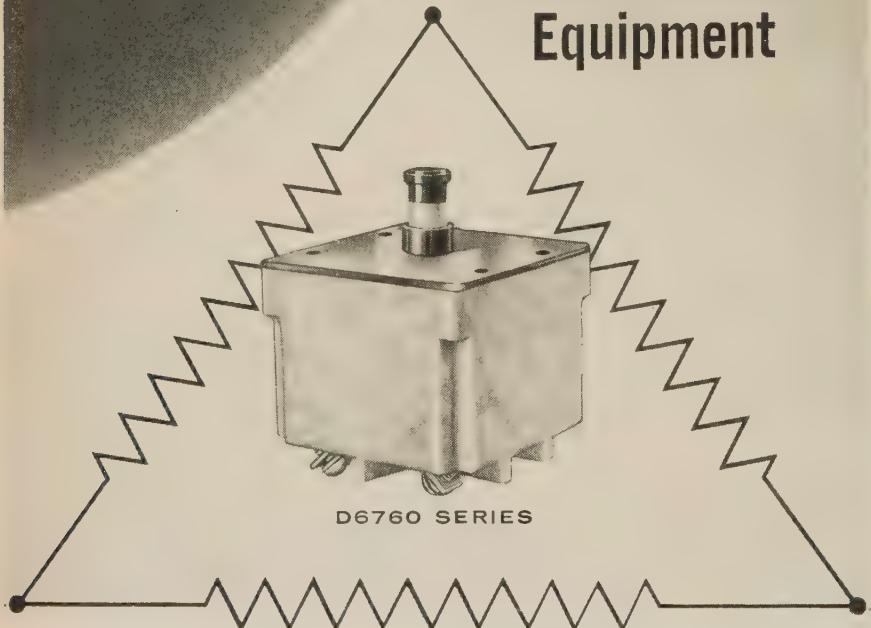
New Multimillion-Dollar Research Center under construction in Southern California's San Gabriel Mountains—designed to house most of the research facilities of Lockheed's California Division. Here will be found advanced research facilities in all fields related to atmospheric and space flight.



Space transports capable of transporting—to an orbit of more than 1000 miles—a pilot and 1000 pounds of payload, or three passengers equipped to work in space.

# NEW KLIXON Three-Phase CIRCUIT BREAKERS

...for Aircraft  
and  
Ground Support  
Equipment



D6760 SERIES

## Advantages:

- Simultaneous tripping of all three phases with overload in one or more circuits . . . assures positive circuit protection.
- Single button opens or recloses all three phases.
- Quick trip . . . 2 to 6 milliseconds on short circuit interruption.
- Shock resistance 25G's.
- Thermal type . . . weight approximately 8 oz.

The KLIXON D6760 series three-phase circuit breakers are especially designed to handle extremely high AC short circuits. Variations of the D6760 are available providing—larger reset button to facilitate manual operation (-1 model) . . . greater electrical clearances between phases for short circuit interruption of 800 to 1000 amperes at 440 volts (-5 model) . . . with a two-pole construction for aircraft AC electrical systems (-6 model) . . . different ampere ratings in each phase to break three loads of different current values simultaneously (-7 model). They are available in ratings from 5 to 60 amperes. Minimum AC rupture capacity 2500 amps, 1  $\phi$ , 120 VAC, 400 cps.

Write for specification data which gives complete details.

## METALS & CONTROLS

3710 FOREST STREET, ATTLEBORO, MASS., U.S.A.

A DIVISION OF TEXAS INSTRUMENTS INCORPORATED  
Spencer Products: Klixon® Inherent Overheat Motor Protectors • Motor Starting Relays  
Thermostats • Precision Switches • Circuit Breakers

Write in No. 568 on Reader Service Card at start of Product Preview Section

## PRODUCT PREVIEW

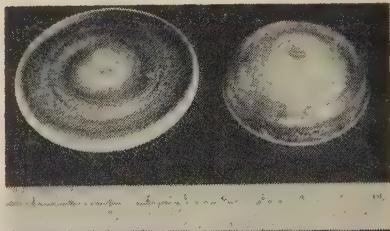
### DIGITAL COUNTER reduces error

This new Gilmore Model 143 Digital servo indicator indicates quickly and accurately forces, fluid flow, weights, which can be converted into ac or dc millivolts. Direct reading digital counter is said to eliminate normal human errors due to parallax and interpolation of reading dials, pointers, and charts. The 6x5- $\frac{3}{8}$  in. front dimensions of the unit require less than one-quarter the panel space of a standard indicator, it is said by Gilmore Industries, Inc., Dept. S/A, 13015 Woodland Ave., Cleveland 20, Ohio.

It is claimed that this device provides a highly readable, digital counter type indication in a space-saving flush-mounted case.

Write in No. 996 on Reader Service Card

### SAPPHIRE WINDOWS in up to five-in dia



Synthetic sapphire windows in diameters up to five in. can now be produced for infra-red, ultraviolet, and microwave applications, says Union Carbide Corp., Dept. S/A, 60 East 42 St., New York 17, N.Y. The windows are also available in large, contoured shapes.

The windows are said to combine outstanding qualities of wideband electromagnetic transmission with hardness and strength at elevated temperatures.

Write in No. 997 on Reader Service Card

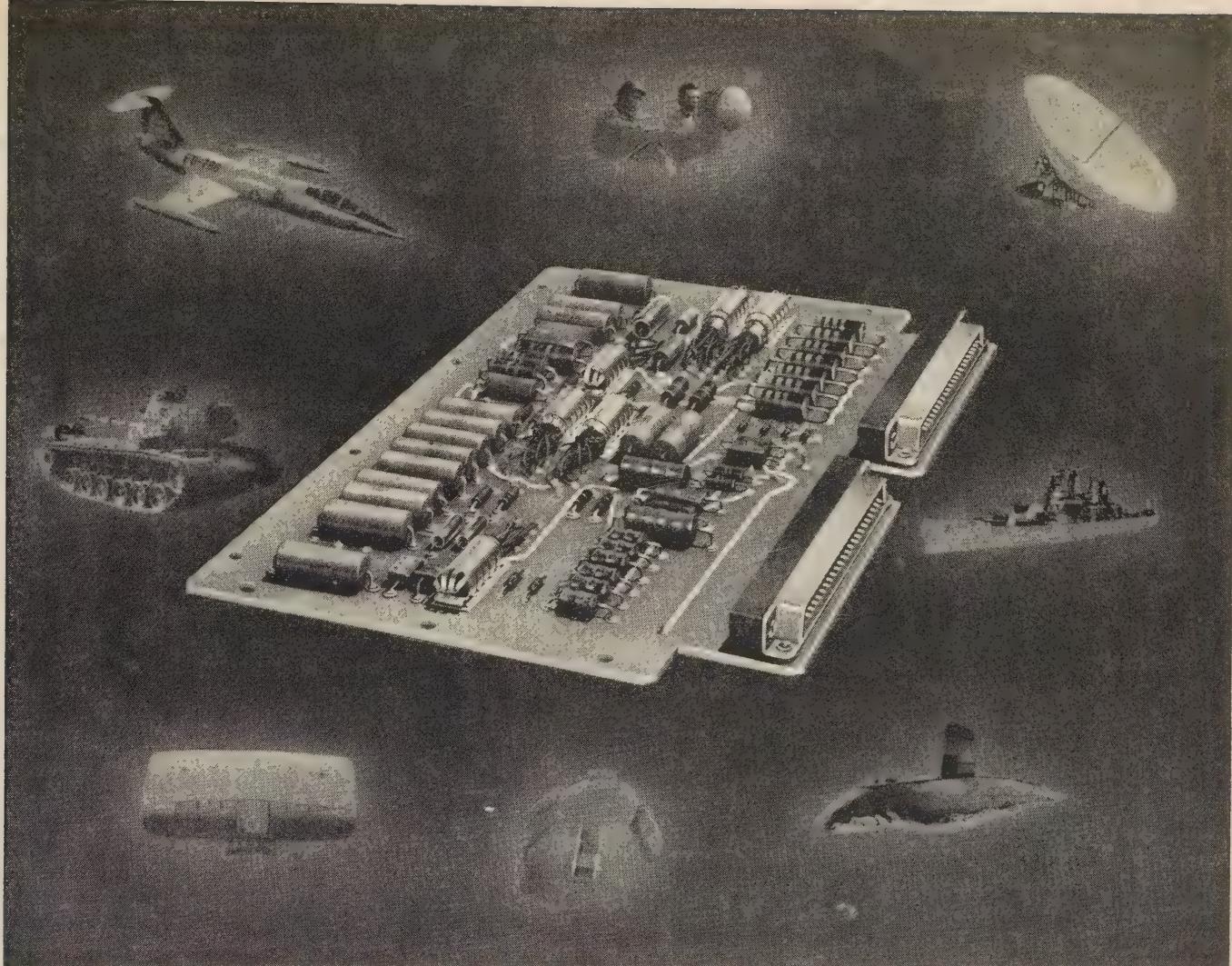
### CHECK VALVES for lox

This new line of check valves, series 155000, for missile or aircraft applications, including lox, incorporates a patented poppet insuring sensitive response to differential pressures as low as 0.25 psi, yet have a working pressure of well above 3000 psi, says Wallace O. Leonard, Inc., Dept. S/A, 373 South Fair Oaks Ave., Pasadena, Calif.

Flight certification testings, it is said, showed these units to have zero leakage with either nitrogen or liquid oxygen. These tests included working pressures up to 4500 psi and missile vibration environments up to 35 g's. They are available in line sizes ranging from  $\frac{1}{4}$  to one inch.

Write in No. 998 on Reader Service Card  
more on page 310

SPACE/AERONAUTICS



Official photographs: U.S. Army, U.S. Navy, U.S. Air Force

## CUSTOM PRINTED CIRCUIT SUB-ASSEMBLIES

*another area where Photocircuits does it better*

Photocircuits—the world's largest supplier of printed circuits for exacting requirements—offers contractors "missile reliability" in complete, *tested sub-assemblies* for military equipment.

Photocircuits is equipped with assembly and test facilities to carry over the same precision quality control from circuit board to final package. Our Inspection and Quality Control Departments are continuously working with Military Specifications such as MIL-Q-5923C, MIL-Std-105A, MIL-P-1877A, etc.; our quality control system is under continual surveillance by the Air Force.

Photocircuits has the experience, equipment and personnel necessary to produce your sub-assemblies . . . quantity or prototype . . . faster, more dependably and at less cost. All under the same roof! This eliminates divided responsibility during fabrication and assembly and assures you the same fine quality in sub-assemblies that is already available in printed boards.

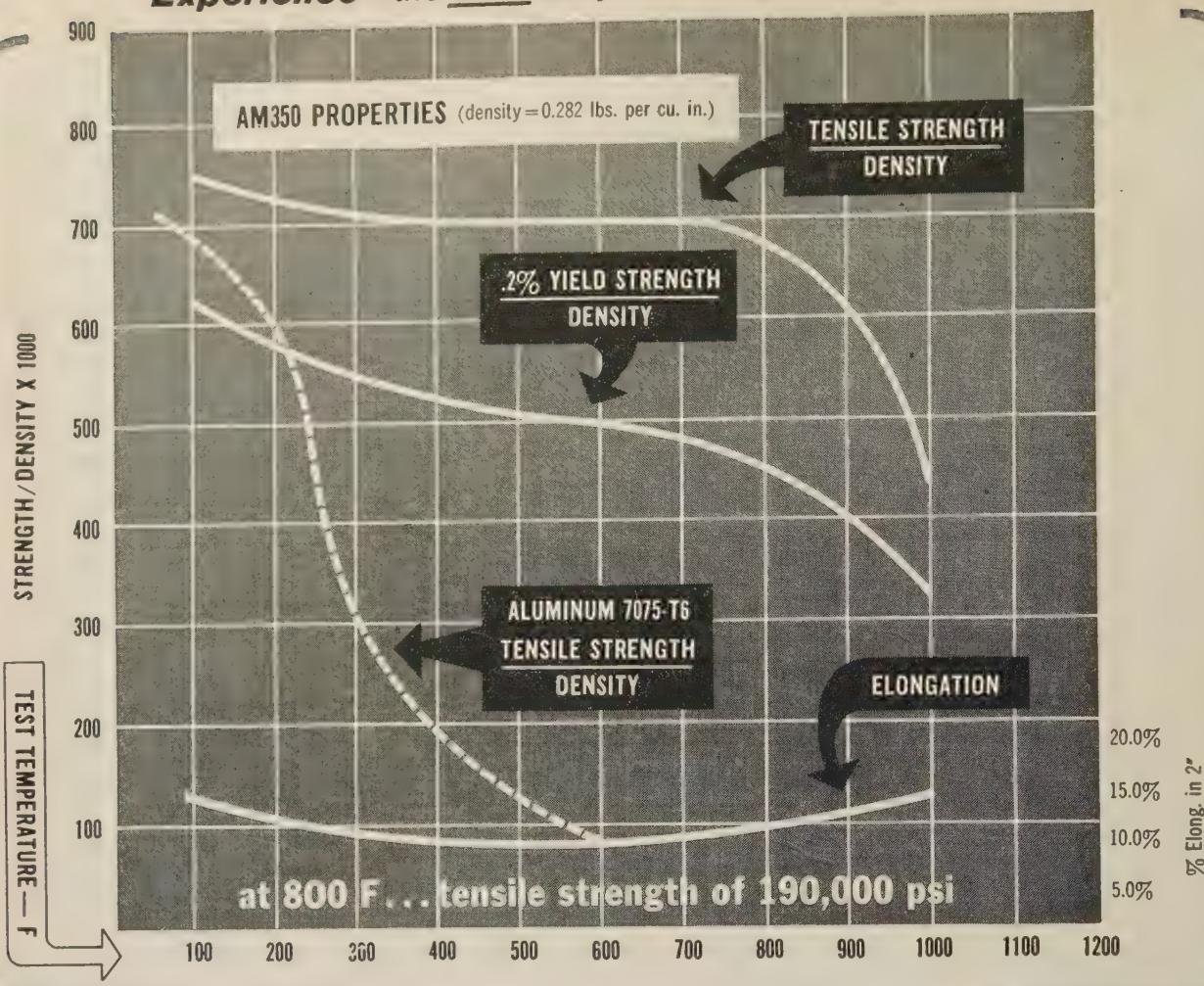
Your nearby Photocircuits Factory Engineer will be happy to give you more complete data on Photocircuits' facilities, or write direct to Dept. A-1374, Photocircuits Corporation, Glen Cove, New York.



**Photocircuits**  
CORPORATION

Write in No. 569 on Reader Service Card at start of Product Preview Section

## **Experience—the extra alloy in Allegheny Stainless**



### **Here are the facts on AM350 and AM355, Allegheny Ludlum's precipitation hardening stainless steels**

A unique combination of highly desirable properties is the usual description of Allegheny Stainless AM350 and AM355 Steels. They combine high strength at both room and elevated temperatures, excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

They are proving the answer to many problems of the air age. Airframe and other structural parts, pressure tanks, power plant components, high pressure ducting, etc. are all natural missile and supersonic aircraft applications for AM350 and AM355.

**Availability:** AM350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM355, best suited for heavier sections, is available in forgings, forging billets, plate, bar and wire.

**Corrosion resistant:** Being stainless steels, these alloys resist corrosion and oxidation. Compared to the older, more familiar stainless grades, their corrosion rating is better than the hardenable grades (chromium martensitic) but generally less than the old corrosion resistant standbys, the

18 and 8's. Stress corrosion is resisted at much higher hardness levels than with martensitic stainless.

**Simple heat treatment:** High strength is developed by two methods, both involving less than ordinary temperatures and minimizing oxidation and distortion problems. The most popular, and one that develops slightly better properties, is the Allegheny Ludlum developed sub-zero cooling and tempering (SCT condition). The material is held at minus 100 F for 3 hrs plus 3 hrs at 850 F. Alternate method is Double Aged (DA): 2 hrs at 1375 F plus 2 hrs at 850 F.

**Easy fabrication:** AM350 and AM355 can be spun, drawn, formed, machined and welded using similar procedures as with the 18-8 stainless types. In the hardened condition (SCT & DA) some forming may be done . . . 180 degree bend over a 3T radius pin. Also it can be dimpled in the hard condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM350 and AM355." *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.* Address Dept. AV-22.

WSW 7327

# **ALLEGHENY LUDLUM**

Export distribution: AIRCO INTERNATIONAL

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

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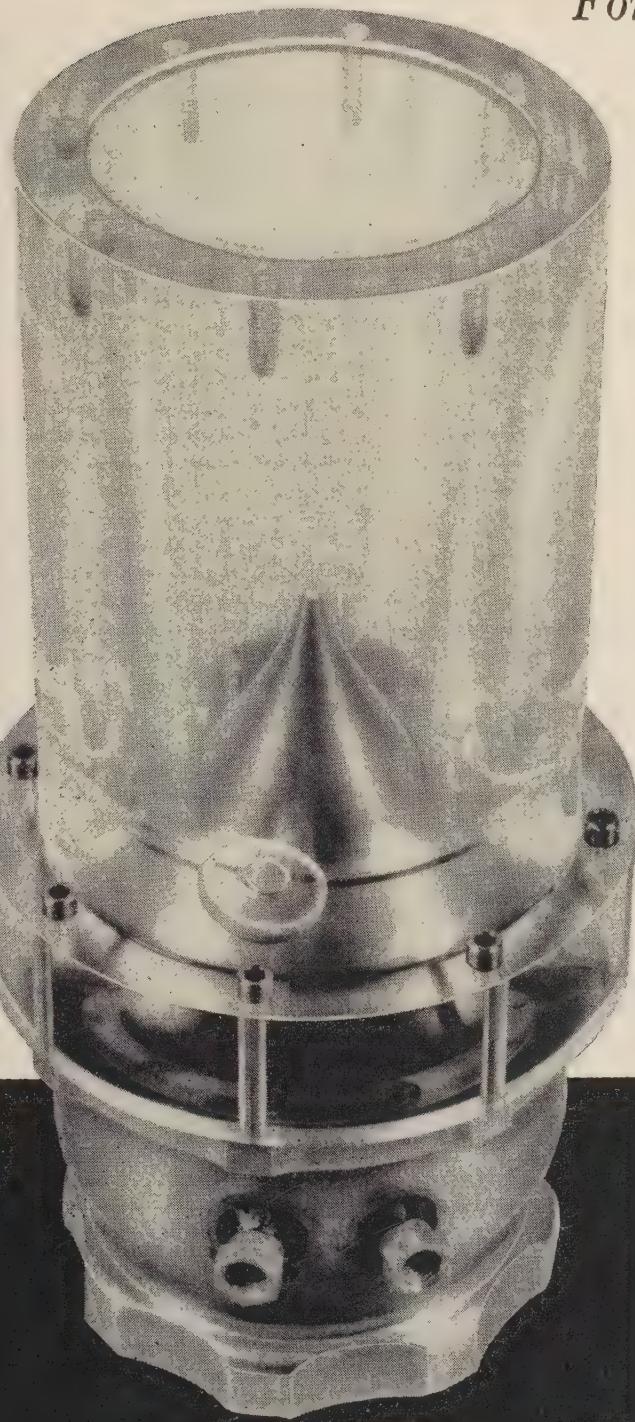


SPACE/AERONAUTICS

*For drastic weight and space reduction!*

*For safest handling of cryogenic, exotic,  
radioactive and conventional fluids!*

*For unsurpassed reliability!*



**COMPONENTS DEPARTMENT  
REACTION MOTORS DIVISION**

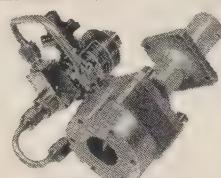
# VENTURI Shut-off VALVES

*... in modern aircraft and  
missile propulsion systems,  
ground handling and nuclear applications*

- No dynamic seals
- Fail safe
- Low pressure drop
- High reliability
- Minimum of moving parts
- Zero leakage
- Low energy requirement
- Line pressure operated
- No external actuation
- Suitable for hazardous fluids, exotic fuels

The Venturi Shut-off Valves shown here are typical of the advanced valve design and development capability of Reaction Motors—pioneer in rocket engines, missile components and support equipment. Capabilities include all facets of design, development and qualification testing of valves, gas pressure regulators and disconnects. Complete in-plant environmental test facilities. Wide experience in designing for cryogenic, boron, exotic and conventional fluids. Currently in production on huge (11") ICBM quick disconnect valves, IRBM regulators and X-15 components and valves for classified projects.

*Reaction Motors can deliver valves designed to your special requirements within 6 to 12 weeks!*



X-15 Hydrogen Peroxide Valve



4" Decaborane Shut-off Valve



Cryogenic Relief Valve



Cavitating Venturi Shut-off Valve

**Thiokol** CHEMICAL CORPORATION

Ford Road, Denville, New Jersey

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# GILMORE

high accuracy  
THRUST • WEIGHT • FORCE MEASURING SYSTEMS

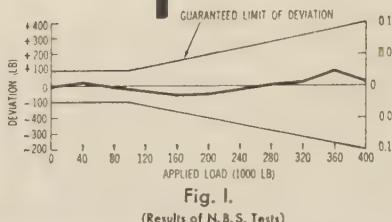
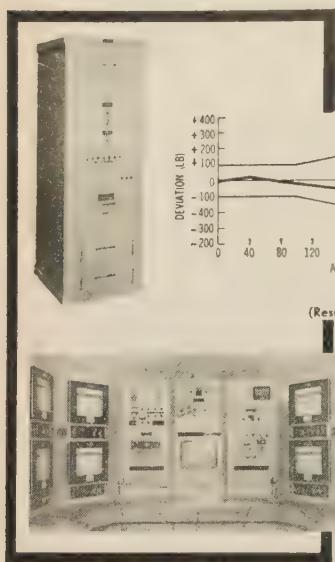


Fig. 1.  
(Results of N.B.S. Tests)

## Edwards Air Force Base COMBINATION WEIGHT & THRUST MEASURING SYSTEM

Designed for all existing and presently planned aircraft. Thrust capacity, -250,000 to +500,000 lbs. Weight capacity, 1,200,000 lbs. Accuracy,  $\pm 1/10\%$ . For technical bulletins on Gilmore thrust, weight, and force systems, write Dept. SA-10

Manufacturers of: Multi-Channel Plotters • Weighing Systems • Thrust and Force Measuring Systems • Strain Gage Instrumentation • Digital Indicating Potentiometers • Data Loggers

Instrumentation Systems for Industry and Science

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13015 Woodland Ave. • Cleveland 20, Ohio • RANDolph 1-6400

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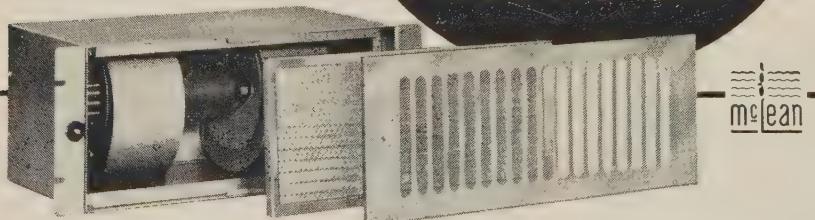
### For Electronic Applications

Rack-Mounted • Compact

Ready-To-Use • Low Cost

High Efficiency • Quiet

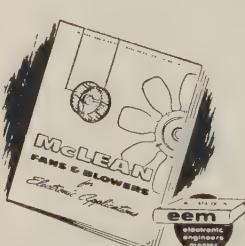
The  
**WORLD'S  
Most Practical  
COOLING UNIT**



### From the World Leader in Packaged Cooling!

McLean's Model 2E408A popular cooling units are the industry's standard . . . there are no better packaged blowers available. Over 10,000 of them are in use, cooling transistors, power supplies, and electronic tubes in systems all over the world! They provide high velocity, and fast cooling in a minimum of space (7 inches x 19 inches, 300 CFM.) McLean has a complete line of fans and blowers in every size for every cooling application. Mil. Spec. equipment for packaged cooling also available.

**McLEAN** ENGINEERING LABORATORIES  
World Leader in Packaged Cooling  
Princeton, New Jersey — WALnut 4-4440  
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#### FREE TECHNICAL DATA

- 24 Page Catalog
- 12 Page Article Forced Convection Cooling
- Specification Sheet on Reversible Fans

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### PRODUCT PREVIEW

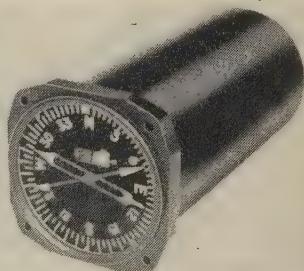
#### FREON URETHANES have low K

A development in the area of Freon expanded urethane foams for the low temperature insulation field is said to be a "radically" new "Lockfoam" polymer that exhibits "one-half the thermal conductivity (K factor) of the polymers used in existing foams." Freon retention and a closed cell content is said to be in excess of 95%. Physical properties of the foams are slightly higher with "virtually no loss of K factor due to ageing," according to Nopco Chemical Co., Plastic Division, Dept. S/A, North Arlington, N. J.

Used in conjunction with Freon, produces K values of about .1, and, because of its structure, retains the Freon.

Write in No. 1001 on Reader Service Card

#### AIRCRAFT INDICATOR has triple function



The Type 9813-02 bearing distance heading indicator provides, on a single indicator face, data on two relative bearings, distance and magnetic heading, says John Oster Mfg. Co., Dept. S/A, 1 Main St., Racine, Wisc. The device is designed for TACAN, VOR and other navigational systems.

Three components of a TACAN system may be replaced by the indicator when it is used with an Oster coupler, and three indicators may be used in parallel with the coupler. The unit has an operating temperature range of -55 to + 71 deg C, ac power input is 15 va, and the unit operates on 26 V 400 cps, and 28 V dc.

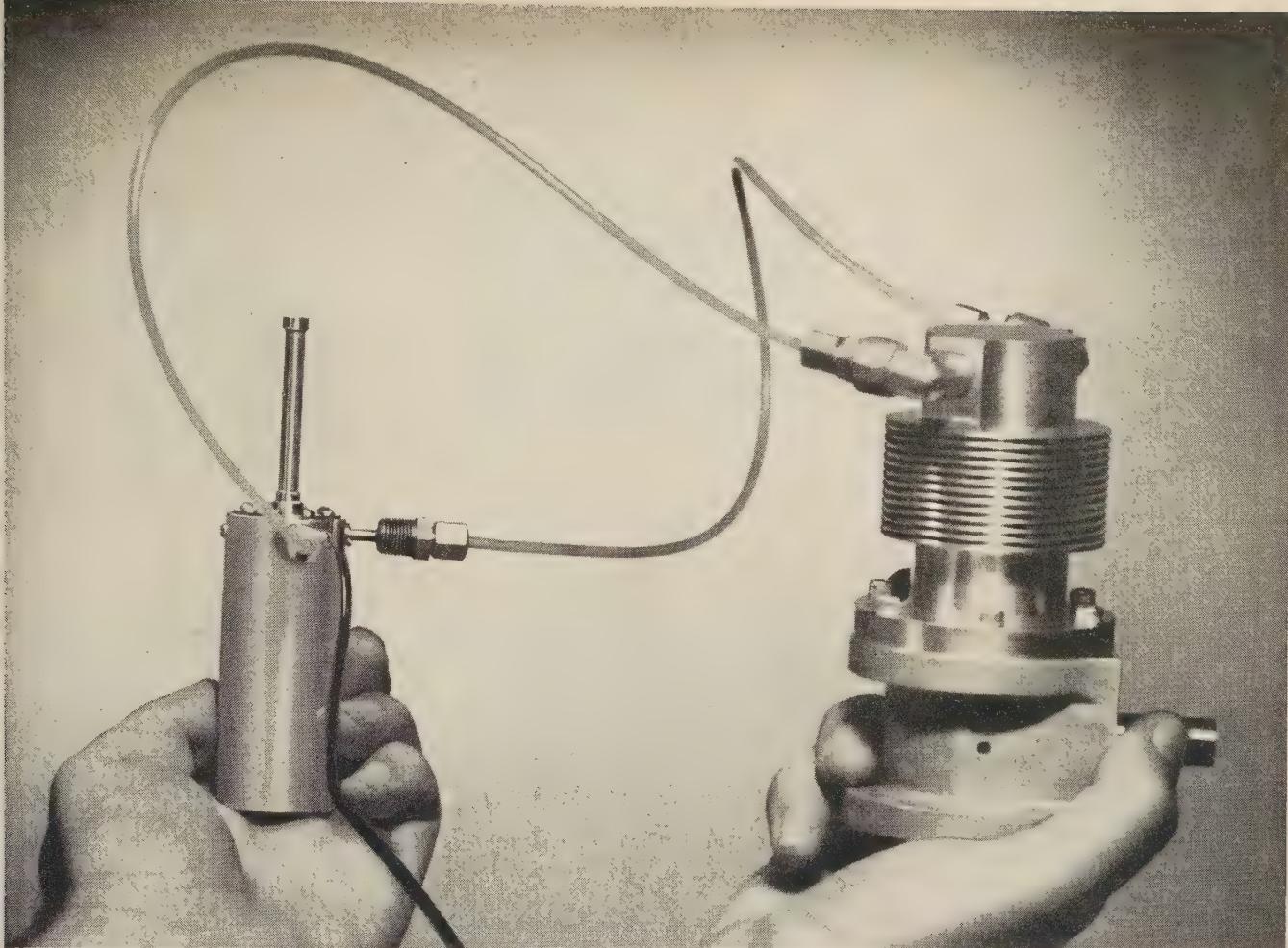
Write in No. 1002 on Reader Service Card

#### GLASS CRYSTAL DIODES are subminiature

This versatile line of all-glass, subminiature crystal diodes for use in radio, hi-fit, television, data processing, and other military and commercial electronic applications, says Sylvania Electric Products Inc., Dept. S/A, 1740 Broadway, N.Y.

With a maximum body length of 0.265 in and a maximum diam of 0.105 in the line includes 3 computer types, 5 gold-bonded types, 3 point-contact types and 6 silicon junction types.

Write in No. 1003 on Reader Service Card  
more on page 312



## Tiny super-coolers from Hamilton Standard FOR INFRARED APPLICATIONS

This is a closed cycle, low-pressure mechanical refrigerating system that can chill infrared cells to any predetermined temperature down to 60 degrees Kelvin (-350°F). Such extremely low temperatures increase the sensitivity of infrared detectors, giving them extended long-wave length response.

The system, one of many possible package configurations, comprises the min-IR-cooler, at left, with a new miniaturized compressor. The combination provides the first reliable miniature system yet devised that will produce such low temperatures. Weighing under 10 pounds complete, it is ideal for operation in missiles or aircraft. It is further adaptable to any IR application and to a wide range of environmental conditions.

The min-IR-cooler was conceived by Arthur D. Little, Inc., and jointly developed with Hamilton Standard to perform with a Hamilton Standard-developed compressor offering high performance at unusually low weight. The system is an important new addition to the complete range of temperature and environmental control devices and systems produced by Hamilton Standard.



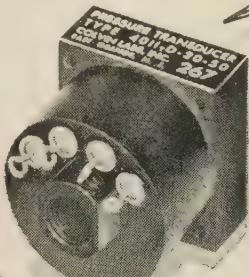
**HAMILTON STANDARD**

*Windsor Locks, Connecticut*

ENGINE CONTROLS • ENVIRONMENTAL CONTROL SYSTEMS • PROPELLERS • STARTERS  
FLIGHT CONTROLS • VALVES • PUMPS • GROUND SUPPORT EQUIPMENT

# NEW MINIATURE PRESSURE TRANSDUCER BY COLVIN

- Only one inch square — one inch long
- Withstands high vibration
- 35 G to 5000 CPS 0-3 to 0-400 psi
- 400 to 10,000 ohms



AVAILABLE IMMEDIATELY

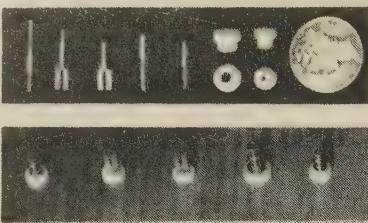
**COLVIN  
LABORATORIES, INC.**

364 Glenwood Avenue, East Orange, N.J.

Write in No. 574 on Reader Service Card

## PRODUCT PREVIEW

### TERMINALS for hard usage



A series of teflon insulated terminals, feed thru's, and test points suitable for hard uses in general purpose applications. Loc-fit utilizes a 2-piece construction consisting of a teflon grommet, which mates during the assembly operation with any one of the numerous standard terminal configurations available, says Litton Ind. Inc., Dept. S/A, 336 North Foot-hill Rd., Beverly Hills, Calif.

Loc-fit can be installed by hand or with automatic production machine facilities. Only two sizes of grommets, miniature and subminiature, are required to make up the entire series.

Write in No. 1004 on Reader Service Card

**VOR/ILS INDICATOR**  
is easy to read



Omni-bearing selector numerals  $\frac{3}{4}$  in. high and matte-white or fluorescent markings contribute to excellent readability of INA-21A VOR/ILS indicator data, says Bendix Radio Div., Bendix Aviation Corp., Dept. S/A, Baltimore 4, Md. The device provides VOR and Localizer pointer, glide slope pointer, TO-FROM indicators, three marker beacon indicator lamps, omni-bearing selector, and flag alarms for both pointers.

The INA-21A is a standard, three-in. instrument for cockpit mounting.

Write in No. 1005 on Reader Service Card  
more on page 315

# Varflo

sleeving and tubing

Will do Class A and Class B jobs!  
For the Price of Class A Insulation!

VINYL  
COATED  
sleeve of  
woven

FIBERGLAS  
gives more  
than  
adequate  
insulation to

YOUR WIRE  
under  
extreme  
conditions—  
that's  
Varflo

Wherever you use either—or both—Class A and Class B sleeving and tubing, Varflo will save you money by filling the requirements of both classes at the cost of Class A insulation!

Varflo vinyl-coated Fiberglas Sleeving and Tubing with its superior qualities of flexibility and greater dielectric strength under all conditions make it ideal for both Class A and Class B installations.

- Flexible, it can be bent or even tied in knots without cracking or crazing.
- Resistant to water, alkalis, mild acids, oils and greases.
- Tough and stands up under vibration. Ideal for "After Treatment" operations.
- Longer Lasting at high temperatures. Withstands hundreds of hours at 300°F.
- More Stable, retains dielectric value when pulled back during soldering.
- Available in 3 NEMA Grades, B-A-1, B-B-1, and B-C-2 in 10 colors, in coils, 36" lengths or short pieces.

**Send Today**

for complete line of samples and recommended uses.

**Varflex**  
CORPORATION  
Makers of Electrical  
Insulating Tubing  
and Sleevng



**VARFLEX CORPORATION, 500 W. Court St., Rome, N.Y.**  
Write in No. 575 on Reader Service Card

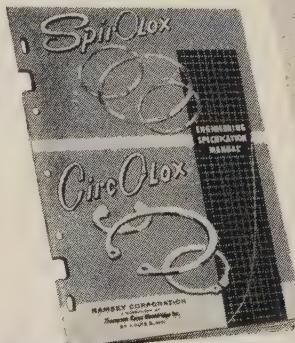
312

# FREE!

### ENGINEERING INFORMATION CATALOG

Shows you how to determine  
which Ring Gives You the  
**ONE BEST ANSWER**  
to Problems of

- ★ REDUCING ASSEMBLED COST
- ★ IMPROVING APPEARANCE
- ★ INCREASING PERFORMANCE



**Spirolox • Circolox**

ONLY RAMCO MAKES BOTH  
MODERN TYPES OF RETAINING RINGS

**Retaining Rings by Thompson Products RAMCO DIVISION**

Box 513, Dept. N, St. Louis 66, Missouri

another product of **Thompson Ramo Wooldridge Inc.** automotive group



548

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SPACE/AERONAUTICS

# New Kaiser Aluminum Weldable Alloys

Aluminum alloys 5083 and 5086 have been developed by Kaiser Aluminum for welded structures requiring maximum joint strength and efficiency, particularly those subject to impact or dynamic loading.

Kaiser Aluminum alloys 5083 and 5086 are high strength, non-heat-treatable, weldable alloys offering seven distinct advantages:

1. GREATER DESIGN EFFICIENCY FOR WELDED STRUCTURES.
2. SUPERIOR WELDING CHARACTERISTICS.
3. EXCELLENT FORMING PROPERTIES.
4. HIGH RESISTANCE TO CORROSION.
5. ECONOMY EQUAL TO OTHER NON-HEAT-TREATABLE ALLOYS.

6. IMPROVED WELD ZONE DUCTILITY.
7. HIGH STRENGTH IN THE AS-WELDED CONDITION.

These weldable alloys are designed with improved properties for products subject to impact or dynamic loading. They have proved, through extended testing and on-the-job use by many industries, complete reliability under every requirement imposed upon them.



A new amphibious, air transportable and air-droppable aluminum armored personnel carrier, the M113, built by Food Machinery & Chemical Corporation's Ordnance Division, San Jose, California, is shown being loaded aboard an Air Force C-124. The M113 was en-

gineered and developed under the direction of Ordnance Tank-Automotive Command U.S. Army to replace the steel model M59. The hull of the vehicle is primarily made of Kaiser Aluminum alloy 5083 plate, extrusions and forgings.

## FASTER WELDS POSSIBLE

An outstanding characteristic of these high magnesium-aluminum alloys is their ability to take full advantage of inert-gas, shielded-arc welding methods. Fast, superior welds and pressure tight joints are thus assured. These are the strongest A.S.M.E. approved aluminum alloys available for the fabrication of unfired pressure vessels without thermo stress-relieving.

Many military products are now being made better at less cost with Kaiser Aluminum alloys 5083 and 5086. The M-113 track vehicle illustrated in Figure 1 is one example. Others include such products as missile structures and skins, missile containers, cryogenic tanks, radar antenna, destroyer gun mounts, crew boat hulls, bridges, overhead cranes, flatbed trailers and armored and amphibious vehicles.

Available in sheet, plate, forgings and extrusions in annealed and rolled tempers, alloys 5083 and 5086 make possible hundreds of new uses for aluminum in military applications. If you want further information, we'll be glad to assist you. Our staff of specialists in metallurgical research, product engineering and field engineering is at your disposal. Call or write:

Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

**FREE!** A Complete Portfolio  
On Aluminum  
In The Defense Industry



For your information and reference, Kaiser Aluminum offers the complete results of its comprehensive survey of the uses of aluminum in the missile industry — plus data on alloys 5083 and 5086 as used in cryogenics and other military applications. For your free portfolio, write for "Aluminum In The Defense Industry": Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

## TYPICAL MECHANICAL PROPERTIES OF ALUMINUM ALLOYS 5083 AND 5086 COMPARED TO ALUMINUM ALLOY 6061 AND MILD STEEL

	5083		5086				6061		Mild Steel	
	"O"	"H113"	"O"	"H32"	"H34"	"H112"	"O"	"T4"	"T6"	As Welded
Tensile Strength (psi)	42,000	46,000	38,000	42,000	47,000	39,000	18,000	35,000	45,000	60,000 Min.
Yield Strength (psi)	21,000	33,000	17,000	30,000	37,000	19,000	8,000	21,000	40,000	32,000 Min.
Elongation (% in 2")	22	16	22	12	10	14	30	25	17	25
Fatigue Strength, psi		23,000			15,000	22,000	9,000	14,000	14,000	34,000
Ultimate Shearing Strength	25,000		23,000		27,000		12,000	24,000	30,000	42,000
Mod. of Elasticity, psi	$10.3 \times 10^6$		$10.3 \times 10^6$				$10.0 \times 10^6$			$30.0 \times 10^6$
Estimated Welded Joint Efficiency		91%					91%	100%		96% 67% 100%
<hr/>										
Typical Prop. of Sound Welds (Machined Flush)										Reheat Treated to T6
Tensile Strength (psi)		43,500				39,000			43,000	29,000 66,000
Yield Strength (psi)		22,000				17,000			30,500	17,000 55,000
Elongation (% in 2")		16				21			5	5-13 25%
Filler Alloy		5183				5356			5356	5356 E6020

## TYPICAL PHYSICAL PROPERTIES

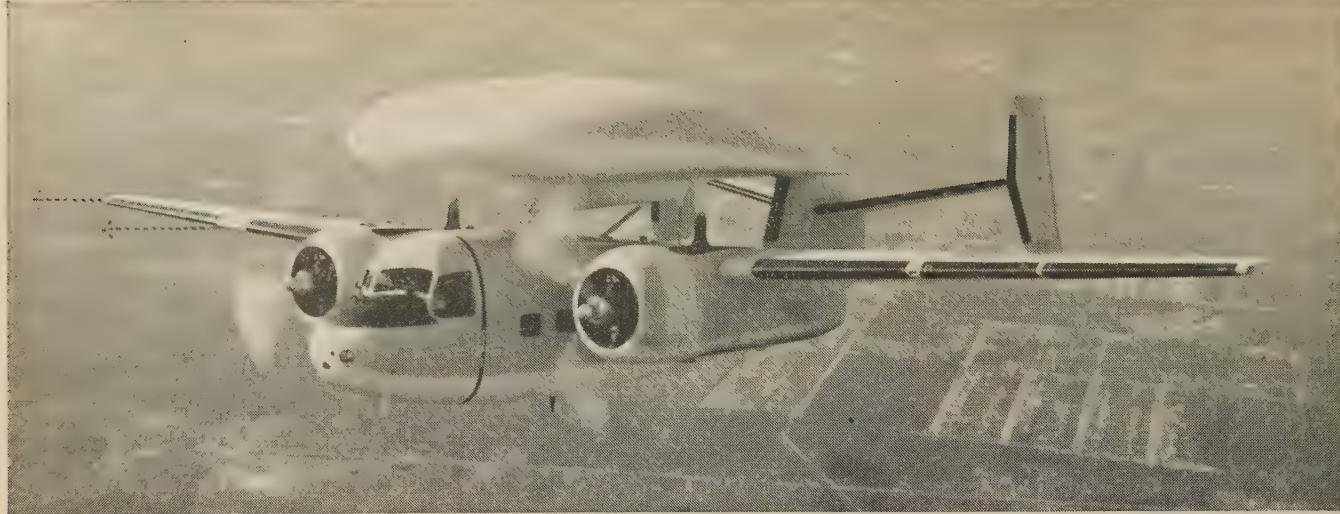
	5086	5083	6061	Mild Steel
Density (lb./cu. in.)	.096	.096	.098	.284
Specific Gravity	2.66	2.66	2.70	7.88
Thermal Conductivity at 25°C (CGS units)	.30	.28	.39	.12
Average Coefficient of Thermal Expansion	$68^{\circ}\text{F}$ to $212^{\circ}\text{F}$ (approx.)	$13.2 \times 10^{-6}$	$13.2 \times 10^{-6}$	$13.1 \times 10^{-6}$
Melting Range (approx.)	1084-1184°F	1065-1180°F	1080-1200°F	2600-2800°F

## NOMINAL CHEMICAL COMPOSITION

5086: Magnesium, 4.0%; Manganese, 0.45%; Chromium, 0.10%
5083: Magnesium, 4.45%; Manganese, 0.75%; Chromium, 0.10%
6061: Magnesium, 1.0%; Copper, 0.25%; Silicon, 0.60%; Chromium, 0.25%
A201B: Carbon, 0.20%; Manganese, 0.60%; Phosphorous, 0.02%; Sulfur, 0.02%; Silicon, 0.23%



THE BRIGHT STAR OF METALS



GRUMMAN'S "SAUCER-TOPPED" WF-2 TRACER, early-warning airplane for Navy carrier operation, carries long-range radar detection equipment.

## BENDIX 20 KVA GENERATING SYSTEM PROVES TREMENDOUS VERSATILITY

Here is a lightweight, transistorized, AC generating system that brings extreme dependability to its many applications. First developed for the USAF for one of its Century series fighters, the Bendix 20 KVA system will soon be flying for the U.S. Navy on Grumman's WF-2 and Sikorsky's HSS-2.

The Bendix system regulator will provide close voltage regulation and will hold transients to a minimum with rapid recovery. The protection panel

will protect the critical aircraft components from under- and over-voltage and from under- and over-frequency.

Offers unusual effectiveness on missiles and on a wide variety of aircraft—in fact can be used on any engine-driven, air-driven, hydraulic-driven or pneumatic-driven application . . . either airborne or ground. Get further details from BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

West Coast Office: 117 E. Providencia, Burbank, Calif.  
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.  
Canadian Affiliate: Aviation Electric, Ltd., P. O. Box 6102, Montreal, Quebec.



SIKORSKY HSS-2, designed for long over-water flight and low-altitude hovering—even alighting on water—during sonar anti-submarine missions.

Write in No. 580 on Reader Service Card at start of Product Preview Section

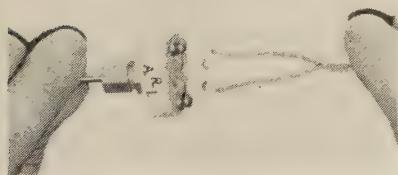
### MAGNETIC AMPLIFIER for low-level signals

Each of the four types available from the line of PREAC 60-cps high sensitivity magnetic amplifiers can be used by itself or as a pre-amplifier for data sensing devices, such as thermocouples, strain gages, bolometers, as well as for high impedance dc sources, says Airpax Products Co., Seminole Div., Dept. S/A, Fort Lauderdale, Fla.

The units produce full output with but millimicrowatt inputs and provide power gains greater than 50 db with a full linear output of 2 volts into a 5000 ohm load. The amplifiers are rated for operation from  $60 \pm 6$  cps lines at  $115 \pm 11$  rms. volts. Power drain is less than 1.5 W.

Write in No. 1009 on Reader Service Card

### HIGH-HEAT CONNECTOR for thermocouple use



Direct contact of the thermocouple lead wire to the thermocouple is featured in this high-temperature thermocouple connector. The connector is mounted on the thermocouple shaft by means of a brass compression fitting, according to Aero Research Instrument Co., Dept. S/A, 315 N. Aberdeen St., Chicago 7, Ill.

Two-post and four-post connectors are available, and the devices will operate at temperatures to 1000 deg C.

Write in No. 1010 on Reader Service Card

### ROTARY SWITCH in compound design

This rotary switch design is a combination of several switches operated by a common rotary shaft. Hetherington Type WC-1447, six 15-ampere snap-action pushbutton switches are arranged individually around the periphery of an aluminum case. A cam coupled to the shaft holds five of the six switches in the operated contact position. As the shaft rotates, individual switches are successively transferred from the operated to the normal contact position. Cams may also be designed to operate more than one switch at a time, according to Hetherington, Inc., Dept. S/A, Folcroft, Pa.

The individual switches are available in SPST, 2-circuit, 3-terminal, or SPDT circuits.

Write in No. 1011 on Reader Service Card  
more on next page



*Mert Fallon, Field Service Manager  
Honeywell Aeronautical Division*

## 66 Field Service Engineers ...here are opportunities to work in areas of flight control and inertial guidance systems 99

"A unique feature of man's explorations in space is his utter dependence on automatic controls. Flight controls, environment controls, instrumentation and data processing, inertial guidance and navigation . . . these are the work areas of Honeywell Aero, a division of the world's largest producer of automatic controls.

"Field Service Engineers in our group at Honeywell Aero advise and instruct personnel handling all equipment manufactured by the Aero Division. Such a man must, of course, be fully qualified technically—but, in addition, he must be capable of doing a public relations job as he is the sole Honeywell ambassador to the unit he is assigned. Generally, his responsibilities are: to monitor equipment performance (in U.S. and overseas)—to provide information for engineering improvements—to conduct training programs for operational and maintenance personnel—to act as liaison between company and military and with all echelons of maintenance and flight personnel—to monitor maintenance practices, analyze shortcomings, suggest remedial action.

"Currently, there are several openings in our Field Service group for EE's. Military aircraft experience is desirable.

"If you are a qualified engineer interested in a rewarding career in this area of Honeywell Aero, send information on your background, interests, and accomplishments to Bruce D. Wood, technical director, Dept. 847E."

# Honeywell

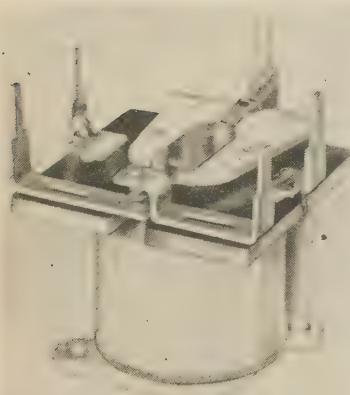
AERONAUTICAL DIVISION



1433 Stinson Boulevard, Minneapolis 13, Minnesota

To explore professional opportunities in other Honeywell operations coast to coast, send your application in confidence to H. D. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

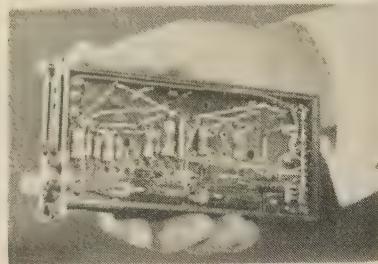
Check Employment Inquiry Form on Page 233

**DC RELAY**  
is low in cost

A low-priced, reliable spot relay has been developed for printed circuitry use in radiosonde, mobile communications and commercial applications, says Price Electric Corp., Dept. S/A, Frederick, Md. The rugged relay is self supporting.

Standard operating voltage is three through 24 V dc, and the contact rating is up to one amp, 50 V dc, resistive. Dc resistance range and power requirement are 8500 ohms and 0.10 W.

Write in No. 1012 on Reader Service Card

**FM AMPLIFIER**  
for airborne recorders

An airborne FM record amplifier that meets military specifications for high-speed, high-altitude flight and operates over a -54 to +71-deg C range has been introduced by Consolidated Electrodynamics Corp., Dept. S/A, 360 Sierra Madre Villa, Pasadena, Calif. The type 1-151, which is designed for use with magnetic tape recorders, has a center frequency range of 1.685 to 54 kc in six steps for recording at tape speeds from 1½ to 60 ips.

Each step is chosen by a plug-in unit in the amplifier. Peak-to-peak sensitivity range is one to ten V, and deviation on all frequencies is 40 per cent. Front panel controls are provided for center-frequency fine adjustment and per cent deviation.

Write in No. 1013 on Reader Service Card

**CORONA REGULATOR TUBES**  
for low-current application

GV3A-700L Corona type regulator tube operates at 700 V and at currents of 0.001 ma or higher. Other models operate in the range of 400 to 1500 V with corresponding low currents, says Victoreen Instrument Co., Dept. S/A, 5806 Hough Ave., Cleveland 3, Ohio.

The tubes are an extension of the designs applied for use in the U.S. Army Satellite Program.

Write in No. 1014 on Reader Service Card

more on page 318

## A seal is only as good as its performance HADBAR O-Rings have durability...

### Where it counts!

Almost any O-ring will function under ordinary conditions... but, to meet tough problems... temperature extremes, corrosion, high pressure in conveying chemicals, searching liquids, fuel oils, steam or heat... in applications, specify the HADBAR 1000-80 O-Ring.

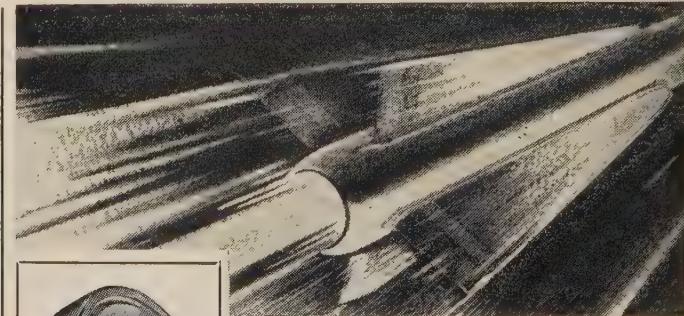
Molded of a high modulus, fuel resistant hydrosilicone rubber compound the HADBAR O-Ring contains no plasticizers, retains low temperature flexibility even after long periods of immersion in fuels, and is not affected by ozone and sunlight.

HADBAR also custom molds and extrudes this rugged hydrosilicone compound into seals, clamps, diaphragms and other parts for a wide variety of applications in many critical areas of advanced design fuel, lubricant and hydraulic systems. It may be the answer to your problem... get in touch with us... we have the skills and facilities to help you.

**HADBAR INC.**

9530 GIDLEY ST., ROSEMEAD, CALIFORNIA. Cumberland 3-4121

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## Minute Giants...

B.M.B. Miniature Bearings to the highest precision limits, are made specially for Space craft, missile or ground support instrumentation.

Stainless Steel for servo applications—B.M.B. have supplied miniature bearings to the American market for the past ten years.

Miniatrization plus reliability equals faultless functioning equals B.M.B. Miniature Bearings

### AGENTS:

David R. Grossman Co., 155 East 44th Street, New York 17, N. Y. U. S. A.

Engis Equipment Co., 431 South Dearborn Street, Chicago, Illinois, U. S. A.

Manufacturing Associates, 1416 Westwood Blvd., Los Angeles 24, California, U. S. A.



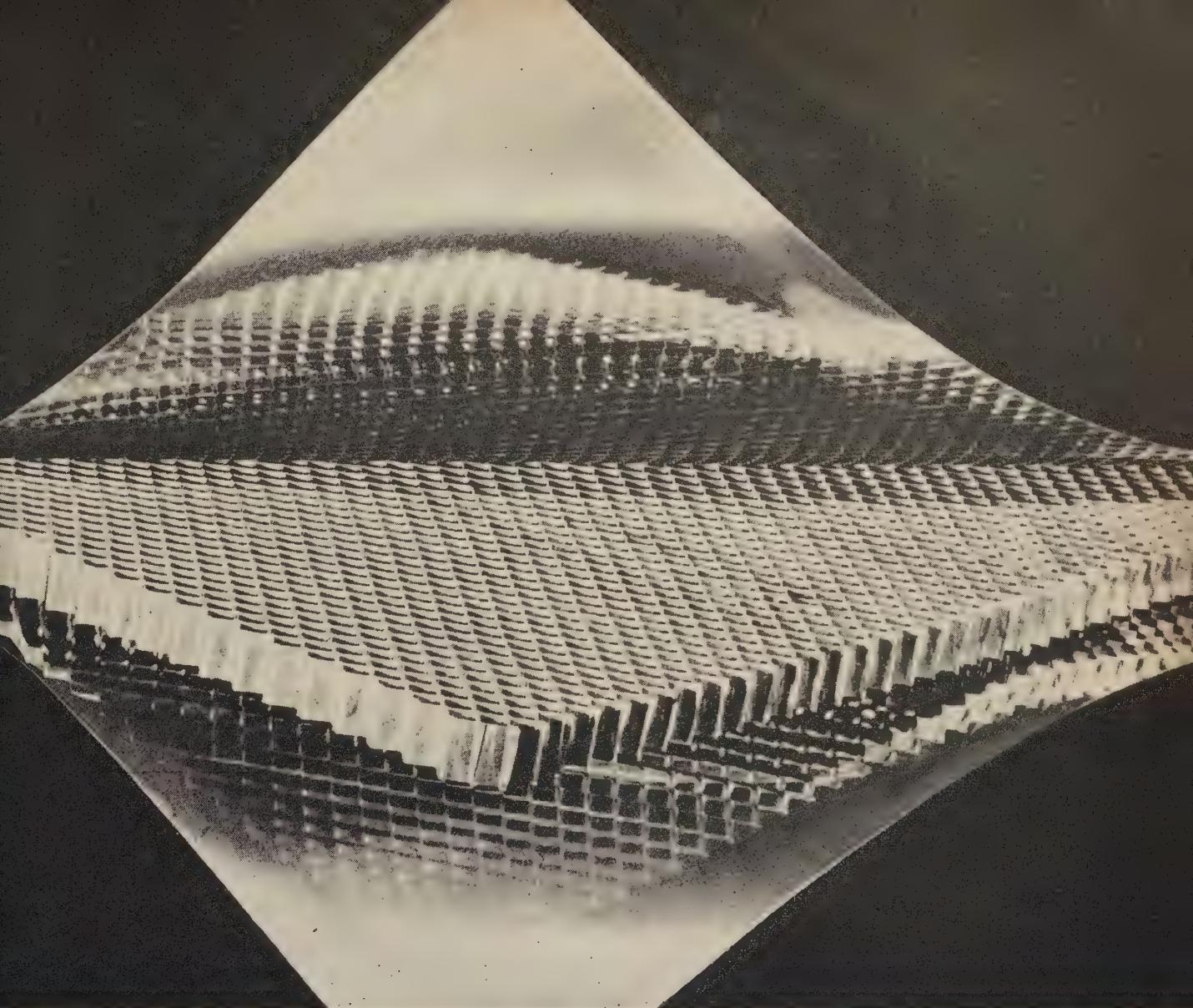
## BRITISH MANUFACTURED BEARINGS CO., LTD.

### Sole Selling Agents:

B.M.B. Sales Ltd., High Street, Crawley, Sussex, England.

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SPACE/AERONAUTICS



## More mileage from Argon in Honeycomb brazing

You can learn a lot about using argon efficiently from the people who make it—Linde Company. This gas is well established as the best atmosphere for honeycomb brazing. Yet some fabricators may be using far greater volumes than they actually need.

This is where LINDE can help in reducing costs. LINDE's "three-phase" concept of argon application includes:

Providing a ready supply of gas to the specifications you require;

Maintaining purity during distribution within your plant;

Getting maximum results from the argon used.

"Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation.

LINDE is uniquely qualified to perform this service because of its extensive work with honeycomb fabricators...and its experience in the production, handling and storage of industrial gases. For aid in the use of argon atmospheres, write Dept. SW-10, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

**Linde**

**UNION  
CARBIDE**

Write in No. 583 on Reader Service Card at start of Product Preview Section

ELECTRONICS: Over, on and under...



## INTERESTED IN TRANSISTOR CIRCUITRY?

Autonetics offers you this challenge: can you develop *original techniques* in transistor circuitry, from either a component or systems level, for any or all of the following systems:

- Inertial Guidance
- Armament Controls
- Flight Controls
- Automatic Checkout Equipment
- Production Test Equipment
- Digital Computers

If you have a BSEE and several years of design, research, development or test experience in transistor circuitry—you can pick your field and share in the many "first" achievements of Autonetics young engineers.

In addition, we'll provide financial support for advanced education at the many fine universities in our area.

Send your resume to:

Mr. B. D. Benning  
Manager, Employment Services  
Dept. D-103  
9150 East Imperial Highway  
Downey, California

**Autonetics**

A Division of North American Aviation, Inc.

## PRODUCT PREVIEW

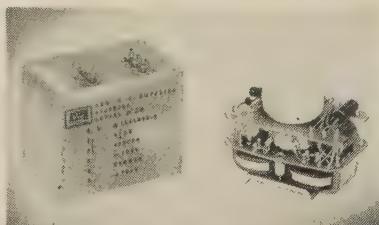
### FERRITE for magnetic cores

MN-31 ferrite material has high initial and maximum permeabilities together with high saturation magnetization and low losses in the 10-500-kc frequency range, says Kearfott Co., Inc., Dept. S/A, 1500 Main Ave., Clifton, N.J. The material has high inherent resistivity, which prevents eddy current losses.

Other desirable characteristics include: low hysteresis losses; 0.2% per deg temperature coefficient of permeability; Curie temperature over 180 deg C; Low magnetization constant (compared with nickel-zinc ferrites); extremely high machinability—may be ground to virtually any shape with tolerances of  $\pm 0.001$  in.; uniform density of 5.0 to 5.1 gm/cm<sup>3</sup>; and high vibrational shock resistance.

Write in No. 1015 on Reader Service Card

### POWER SUPPLY for airborne use



The airborne power supply Model 90122 will supply outputs of +100 V plus or minus five V for 65 ma,  $\pm 25$  per cent, and -100 V plus or minus five V or 20 ma,  $\pm 25$  per cent, from a 115-V, 400-cycle input. Under nominal line and load conditions, maximum primary load is 250 ma rms, says ACF Industries, Inc., Dept. S/A, 11 Park Pl., Paramus, N.J.

The hermetically sealed unit has a two per cent ripple factor and a -35 to +100 deg C temperature range.

Write in No. 1016 on Reader Service Card

### FERROMAGNETICS for high temperature

Two non-memory, inductive-core materials, which have been used successfully as antenna couplers at intermittent service temperatures up to 350 deg C, showed less than 10% change in Q and permeability after 100 hr at 275 deg C in atmospheric conditions, says The Polymer Corp., Dept. S/A, 2140 Fairmount Ave., Reading, Pa.

Known as Ferrotron ferromagnetic materials, the cores are claimed to extend the operating range by 75 to 150 deg C over other compositions. The materials have a positive Q-coefficient and constant permeability.

Write in No. 1017 on Reader Service Card

more on page 322



## Reliability is a most important characteristic of KENNAMETAL\*

Seal rings in pumps handling red fuming nitric acid for rockets face a most severe test against corrosion, especially since they may be in contact with the acid for years before being required to operate.

In one particular assembly, rings were exposed to temperatures of 300° under 45 psi face pressures while rotating 17,500 rpm. The previously used material lasted approximately 120 minutes. Then rings made of Kennametal grade K501 were installed and one of the world's leading designers and manufacturers of aircraft components and systems, reports average life of the Kennametal rings as "over 120 minutes to indefinite."

They state that "the Kennametal rings sealing results have been far superior with no indication of seal face wear" and that "the Kennametal ring has indications of less bending and distortion when installed between two mounting faces making assembly simpler and reducing assembly time."

Chances are some vital components for your equipment can be made from Kennametal to provide unusual resistance to abrasion, erosion or deformation required for valve parts, nozzles, plungers, metering orifices, integrator discs, thermostatic sensor elements, non-lubricated guides and parts to operate at temperatures to 2200°F and above. For specific recommendations on the Kennametal or Kentanium\* composition that will best suit your need, contact your Kennametal Representative. Or, write for Booklets B-111-A and B-444-A. Kennametal Inc., Dept. SP, Latrobe, Pa.

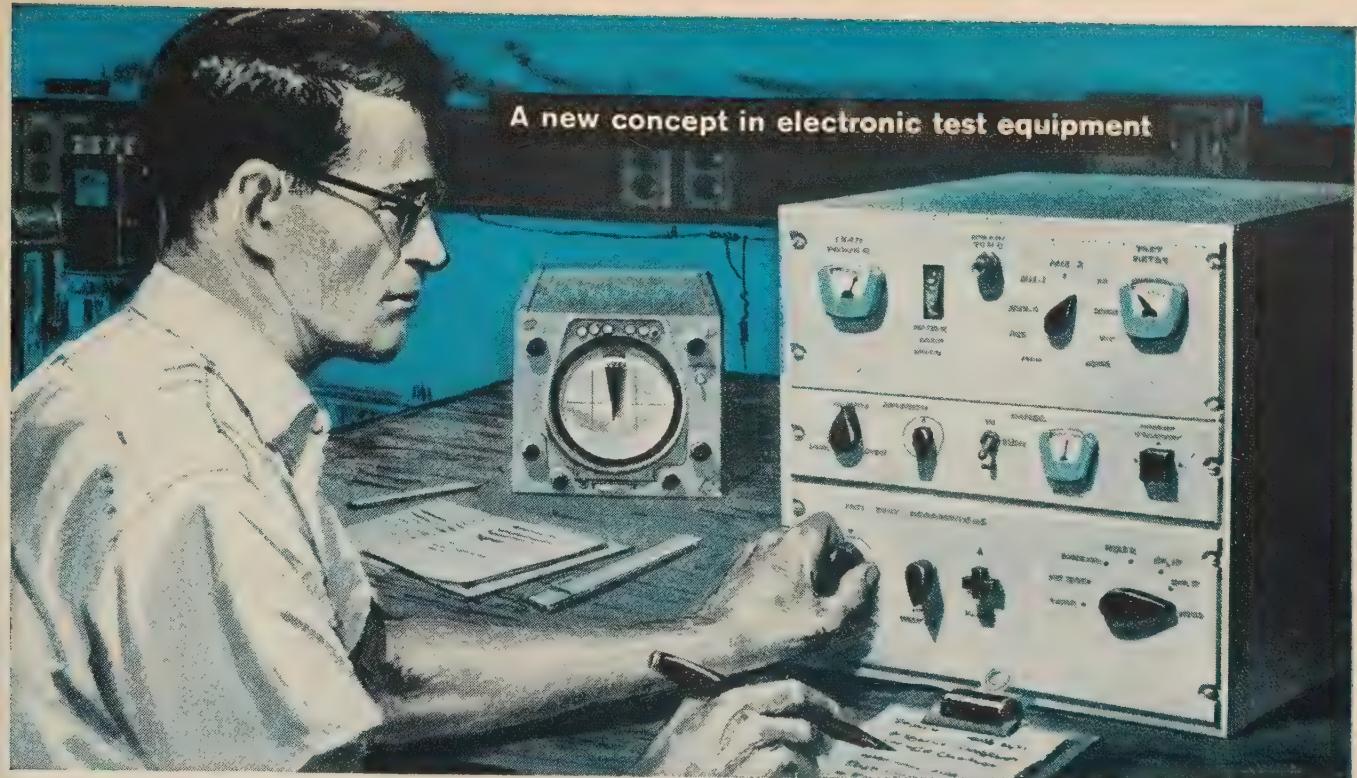
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\*Trademark of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum.

INDUSTRY AND  
**KENNAMETAL**  
...Partners in Progress

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SPACE/AERONAUTICS

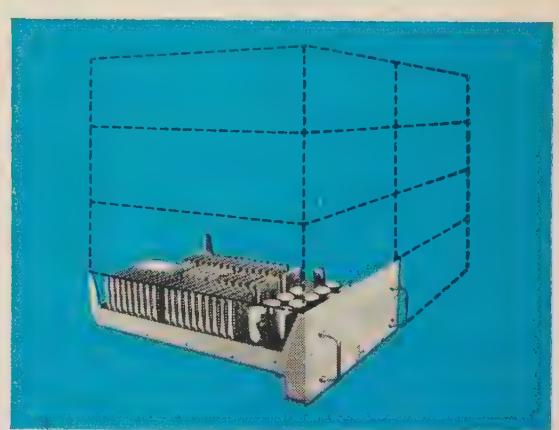
A new concept in electronic test equipment



Assemble...a radar performance monitor...



or a complete weapon checkout system...



with Sperry modular components

## Sperry's new **standardized** test modules adapt to any electronic checking job

Newest trend in electronic testing is development of "universal" equipment adaptable with minor modifications to many different systems. This "building block" concept is encouraged by the armed services to eliminate the need for expensive test equipment designed exclusively for a single weapon system.

### TEST ANY ELECTRONIC SYSTEM

Ready with the answer is Sperry's Microwave Electronics Company which has developed a wide range of *standardized* test components of the modular

type. Physically and electronically compatible with each other, these advanced modules combine to form precision testing equipment capable of checking any kind of electronic system — either the over-all system or subsystems and components.

### FOR LAB, BENCH OR FIELD

These Sperry modules require only minimum adaptation to tailor them to even the most advanced radar or electronic system. Sperry is also ready to take on the design and development of test mod-

ules to fit specific or unusual needs.

Write for more information on this latest Sperry contribution to more effective and reliable operation of electronic systems.

# SPERRY

**SPERRY MICROWAVE ELECTRONICS COMPANY, CLEARWATER, FLORIDA · DIVISION OF SPERRY RAND CORPORATION**  
Address all inquiries to Clearwater, Florida, or Sperry Gyroscope offices in Great Neck · Cleveland · New Orleans · Los Angeles · San Francisco · Seattle

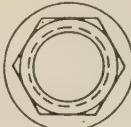
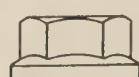
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# 5 Ways to Save Fastener Weight

New FN Featherweight locknut series  
combines minimum mass, outstanding performance



SPS FN-12 Series  
Featherweight Hex Locknut



Up to 72% lighter than commonly used sheet metal or AN Series nuts. Tolerance on squareness of bearing surface to threads is 50% less than required by specification, providing reduction in stress concentration. Vibration resistance exceeds MIL-N-25027 requirements by 50%.

#### Characteristics

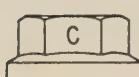
Sizes—#4 through  $\frac{5}{8}$   
Tensile strength—160,000 psi  
on 180,000 psi tensile bolt  
Temperature—550°F max.

Material—Alloy steel  
Plating—Cadmium

SPS Bulletin No. 2426



SPS FN-812 Series  
Featherweight Hex Locknut



Designed for 800°F service. Corrosion and oxidation resistant; low magnetic permeability. Up to 60% lighter than conventional NAS 679 counterparts. Also less costly because made of austenitic stainless instead of A-286 super alloy.

#### Characteristics

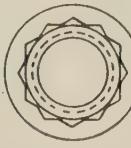
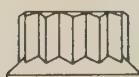
Sizes—#4 through  $\frac{5}{8}$   
Tensile strength—160,000 psi  
on 180,000 psi tensile bolt  
Temperature—800°F max.

Material—Austenitic stainless  
Plating—Silver

SPS Bulletin No. 2521



SPS FN-22 Series Featherweight  
12-Point External Wrenching Locknut



Static strength capable of breaking a 220,000 psi tensile bolt. Lightest locknut of this strength available in sizes #10 through  $1\frac{1}{2}$ . Exceptionally close tolerance on bearing face squareness gives up to 30% longer bolt fatigue life.

#### Characteristics

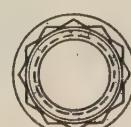
Sizes—#10 through  $1\frac{1}{2}$   
Tensile strength—220,000 psi  
Temperature—550°F max.

Material—Alloy steel  
Plating—Cadmium

SPS Bulletin No. 2487



SPS FN-920 Series Featherweight  
12-Point External Wrenching Locknut



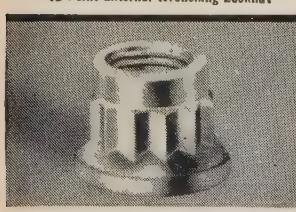
900°F locknut designed for use with high-strength engine bolts having 0.003 in. reduced pitch diameter. Close control of squareness between bearing face and threads makes these the only standard nuts for their temperature meeting squareness requirements of MIL-N-7873.

#### Characteristics

Sizes—#10 through  $\frac{5}{8}$   
Tensile strength—200,000 psi  
Temperature—900°F max.

Material—AMS 6304  
Plating—Nickel-cadmium, Silver

SPS Bulletin No. 2504



SPS FN-1216 Series Featherweight  
12-Point External Wrenching Locknut



Offers 160,000 psi tensile at room temperature; 140,000 at 1200°F. Reduced stress concentrations achieved by maintaining 0.003 in. bearing face squareness. Simulated service tests document high lock retention during repeated 100 hr. exposure to 1200°F while stressed to 90,000 psi.

#### Characteristics

Sizes—#10 through  $\frac{5}{8}$   
Tensile strength—160,000 psi  
Temperature—1200°F max.

Material—SPS-M-118 (A-286)  
Plating—Silver

SPS Bulletin No. 2468

Extensive laboratory tests have been conducted on each design of SPS Featherweight series locknuts to insure their meeting or exceeding specification or application requirements. For bulletins or samples, write SPS—manufacturer of precision threaded fasteners and allied products in many metals, including titanium.

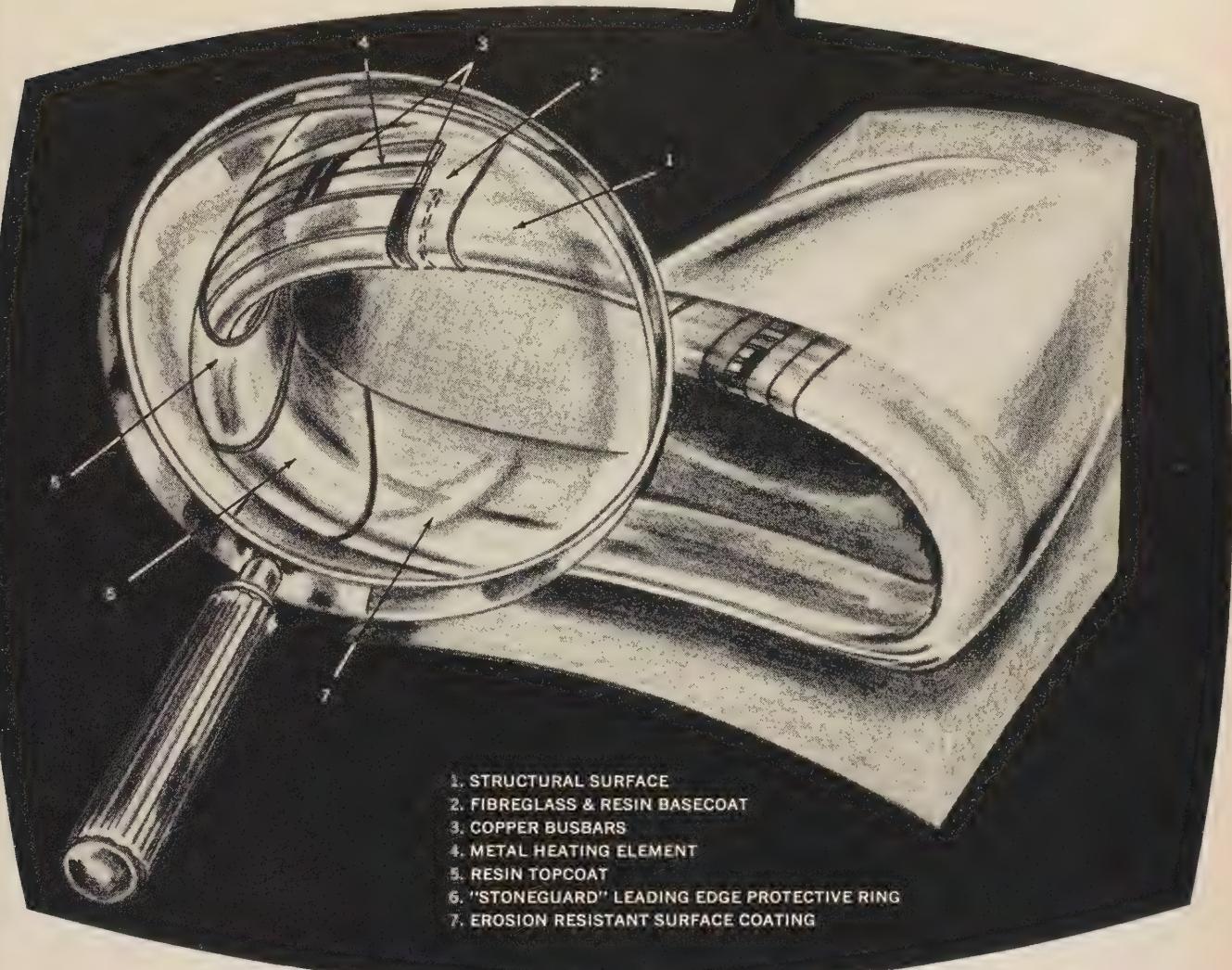
AIRCRAFT/MISSILE Division **SPS**

JENKINTOWN 54, PENNSYLVANIA • SPS WESTERN, SANTA ANA, CAL.

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**napier**  
**SPRAYMAT**  
*anti-icing/de-icing...*

OVER  
15,000,000 MILES  
OF SERVICE



1. STRUCTURAL SURFACE
2. FIBREGLASS & RESIN BASECOAT
3. COPPER BUSBARS
4. METAL HEATING ELEMENT
5. RESIN TOPCOAT
6. "STONEGUARD" LEADING EDGE PROTECTIVE RING
7. EROSION RESISTANT SURFACE COATING

After 9 years of development, testing and service, SPRAYMAT electrothermal ice elimination system has been enthusiastically accepted in the United States, and is in use on such aircraft as Lockheed's Electra and North American's Sabreliner, and was successfully tested on Lockheed's C-130A. SPRAYMAT has long been in use on such aircraft as the Britannia, Comet, Caravelle, Friendship, Vanguard, Viscount 810 and many others.

SPRAYMAT can be applied to *any* surface, of any material, however complex the curvature. Simple field repairability and aerodynamic and thermal efficiency assures its superiority to any existing system.

Basically, as shown in the above diagram, SPRAYMAT consists of, first, a base of insulating resin; next a layer of metallic heater element of a controlled, pre-determined design pattern; and finally a mirror-finish

Visit our Spraymat exhibit in booth 31 at the SAE convention in Los Angeles

coating of insulating resin. Under normal operating conditions, the service life of SPRAYMAT will exceed that of the aircraft structure itself!

Other applications for SPRAYMAT include:  
solid rocket propellant fusing  
radiant heat panels  
heated tools and molds  
de-fogging of camera lenses  
heating of components in unheated  
unpressurized areas  
heat blankets

PacAero is SPRAYMAT's sole United States manufacturer and distributor. A call or letter will bring you into immediate contact with a well-informed SPRAYMAT sales-engineer to discuss the application of SPRAYMAT to your specific ice-protection problems.

**PacAERO**

**PACAERO ENGINEERING CORP.**

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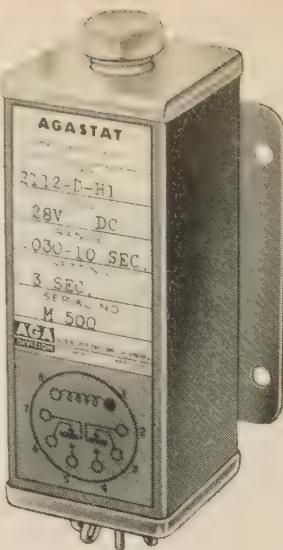
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## MINIATURE AGASTAT®

time/delay/relay

**MEASURES ONLY**  
**4" x 1½" x 1½"**



The Miniature Agastat time delay relay is a space-saving answer to aircraft, missile and computer problems. You get all these valuable features in one small package:

- Easily adjusted timing ranges as short as .030 seconds.
- Repeat accuracy of  $\pm 5\%$ .
- Time delay on energizing or de-energizing.
- For DC or AC operation.
- Hermetically sealed or dust-proof housings.

Write today for the full details on the new miniature Agastat. Dept. A36-1019.



ELASTIC STOP NUT CORPORATION OF AMERICA

1027 Newark Avenue, Elizabeth, N.J.

Gasaccumulator Co., (Canada) Ltd., 12 Gower Street, Toronto 16, Ontario

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## TOTAL TEMPERATURE PROBES PIROT-STATIC TUBES

MODEL 850



MODEL 103



### ILLUSTRATED MODELS

MODEL 850 Meets Mach 3 requirements of MIL-P-25757A (USAF).

MODEL 103 Mach 5 total temperature probe can be used to temperatures of 1500°C.

MODEL 101C Mach 3 total temperature probe. Meets requirements of MIL-P-25726A (USAF).

MODEL 102D Mach 3 Deiced total temperature probe. Accurately measures total temperature during deicing.

Write for New Catalog No. 115811 for description of 50 different REC Probes for liquid, gas and surface measurement.

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HOLLYWOOD 5-1131 in Los Angeles  
MAIN 3-6688 in Seattle  
or Teletype LA 1840 in Los Angeles

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## URETHANE CONTAINER does 3 assembly jobs

This protective shipping container of rigid urethane foam is also a parts assembly jig and a checking fixture for solid fuel rocket engines. Container has a separate cavity for each part to be shipped as it goes down the line. The urethane foam assures protection of the parts in transit, says Dayton Rubber Co., Dept. S/A, Dayton, Ohio.

A wooden dummy is mounted on a board for space utilization and the mold is covered with a thin film of parting agent and a pallet is inverted over it. Mixed urethane foam of a special composition is admitted to the cavity through a hole in the pallet, completely filling the cavity before setting.

Write in No. 399 on Reader Service Card

## INDICATOR LIGHTS with 180° visibility

These miniature indicator lights, designed to specification Mil-L-6723 (ASC), feature two-terminal isolated ground circuits, anodized aluminum cases, and large-area plastic lenses which afford bright, 180° visibility. For use with midget flange base AN3140-type incandescent lamps, the series L14,000 measures 11 $\frac{1}{4}$ " overall, and is available with lenses in a variety of translucent and transparent colors.

Slightly longer, the L15,000 series features a built-in resistor and accommodates NE2D neon lamps for 115v operation, according to Hetherington, Inc., Dept. S/A, Folcroft, Pa. Lenses in the latter series are available in transparent red, amber, and clear.

Write in No. 400 on Reader Service Card

## HEX NUTS save space, weight

This flyweight series T99S low beam hex nut comes in a chrome-moly vanadium alloy steel, with nickel cadmium diffused plating for 160,000 psi at 550°; 90,000 psi at 900°. T99C is available for low magnetic permeability requirements, allowing higher stress levels at 900° than with alloy steel; also in brass for high electrical conductivity and where low strength—60,000 psi—brass screws are being used. Recommended where moderately high initial torque of steel lock nuts is too severe for the screw and high reusability is needed, says Boots Aircraft Nut Corp., Dept. S/A, Norwalk, Conn.

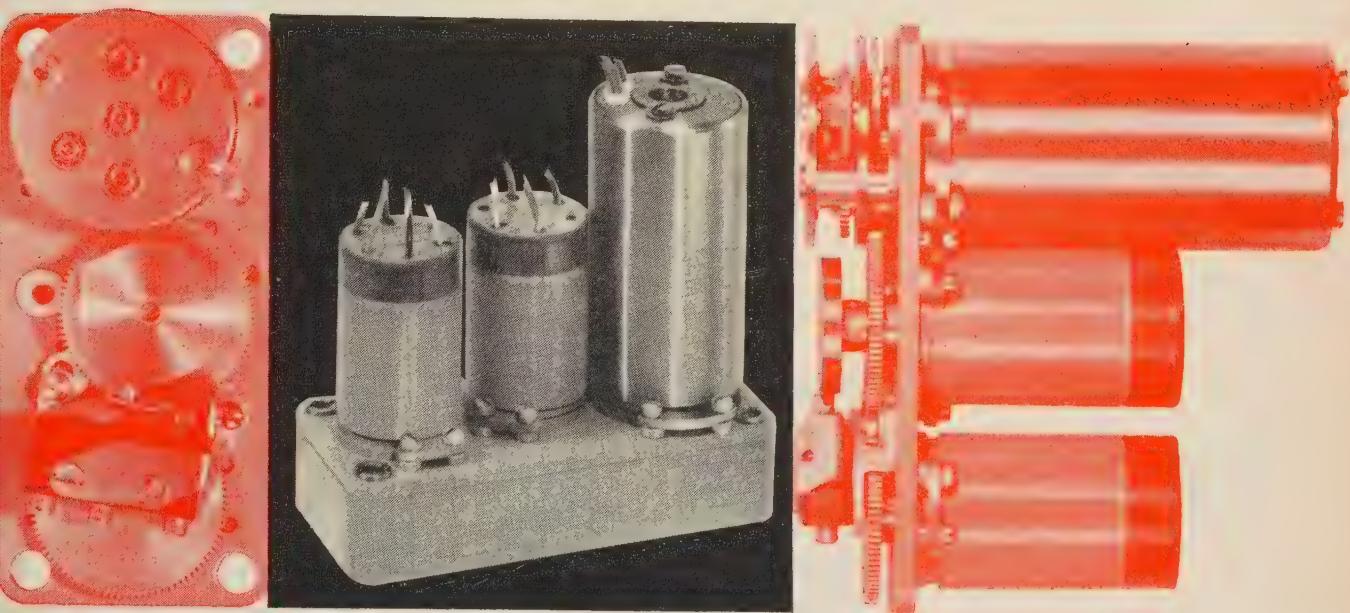
It is claimed that important weight and space savings result.

Write in No. 401 on Reader Service Card

more on page 324

**THOMAS A. EDISON**

**OFFERS YOU SINGLE SOURCE RESPONSIBILITY**



**FOR SUB-MINIATURE ELECTRO-MECHANICAL SYSTEMS**

This sub-miniature, servo-gear train system is designed and manufactured by Edison for use in airborne or ground support equipment. It is one example of Edison's unique ability to supply electro-mechanical systems in one integrated assembly.

Weighing only 9½ ounces this system contains gear train assembly, linear transformer, control transformer and motor generator. Systems such as these can be side or in-line mounted or made in any configuration to meet your requirements.

Edison has complete facilities for designing and manufacturing magnetic amplifiers, computers, transducers, miniature relays servo-motors and gear trains. Unlike other companies who must rely on outside suppliers, Edison offers you single source manufacturing and design responsibility. This is backed by one of the most complete research laboratories in the country, where experienced Edison engineers carry on a continuing program in search of new and improved state of the art designs.

Let the Edison team be your single source for servo components and electro-mechanical systems.

**Thomas A. Edison Industries**

**INSTRUMENT DIVISION**

48 LAKESIDE AVENUE, WEST ORANGE, N. J.

Write in No. 207 on Reader Service Card at start of Product Preview Section



## PRODUCT PREVIEW

# CHROMALOX FLEXIBLE AND MOLDED ELECTRIC HEATERS



Electronic heating harness molded to fit small object. Three woven heaters molded in high temperature refractory and aluminum case (left) and glass and polyester resin (center and right). Small thermostat is molded to base of center heater.



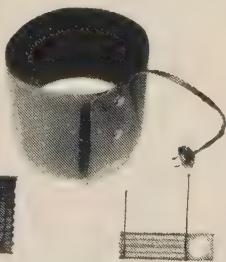
Neoprene rubber molded heater, eliminates ice clogging of aircraft pitot tube.



Silicone rubber laminated heater molded on a  $2\frac{1}{8}$ " spherical radius. Two of these completely cover and protect guided missile storage battery reservoir.



Silicone rubber laminated heater bonded to a metal component for an aeronautical camera.



Neoprene rubber laminated battery heater.



Woven heaters. Temperatures to 800°F. Any size or shape up to 24" wide and to any length. Can be supplied with eyelets, snap fasteners, mounting holes. Moisture and abrasion resistance can be provided by silicone rubber coating.

**Chromalox Flexible and Molded Heaters are shaped-to-fit to put exact amounts of heat where it is needed.**

**FREE**—Send today for new Bulletin J-1003 which gives detailed engineering information. Or, call your Chromalox Representative for personal assistance with any heating problem. 91812



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*Electric Heat*  
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EDWIN L. WIEGAND COMPANY  
7775 THOMAS BLVD., PITTSBURGH 8, PA.

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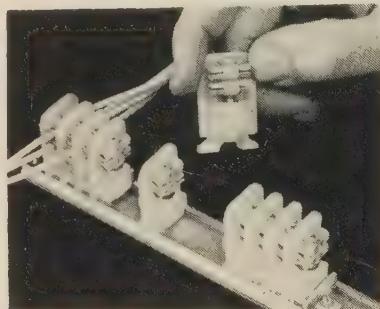
## DIAL ASSEMBLY for servo mounting

This dial assembly permits mounting and dismounting from the front panel of any equipment. Upon the rim of the dial assembly is a machined groove which is used in the same manner as the mounting groove of a synchro, according to Theta Instrument Corp., Dept. S/A, 48 Pine St., E. Paterson, N. J. Convention synchro clamps located on the equipment panel firmly hold the dial.

Specifications: Range, 360° continuous; accuracy, 0.1°; outside diameter, 5"; meets MIL-T-945A requirements.

Write in No. 402 on Reader Service Card

## TERMINAL BLOCK has modular design



inch. Other line sizes and port con from #22 to #12, according to Burndy Corp., Dept. S/A, Norwalk, Conn. The device, in use in missile ground control systems, features individual modules that snap together and are inserted into a steel track and locked by end locks.

Modules have either two or four-tier spring-loaded plate sockets, which may be used for permanent connection or set for quick-disconnect for rapid ring-out, bussing, or circuit changes. They are made of a Nylon compound with very low water absorption characteristics. Tracks are available in lengths up to 32 in. Each foot of track accepts 30 modules.

Write in No. 403 on Reader Service Card

## CONVERTER for dc-dc static

A static converter for computer, portable test equipment, emergency equipment and airborne equipment applications, is hermetically sealed and has been designed so that it is insensitive to physical orientation, says Magnetic Research Corp., Dept. S/A, Hawthorne, Calif. The unit is short-circuit proof and offers 28v dc input.

Specifications are: output power multiple, 150 watt maximum; size 5.0" x 3.5" x 3.7"; weight, 3.5 lbs. Efficiency exceeds 75%. Line regulation less than  $\pm 1\%$ .

Write in No. 404 on Reader Service Card  
more on page 326

## the new Branson pulse-echo



Flaw Detector for contact or immersed testing makes a dramatic improvement in the acoustical "picture" of internal structure.

**SENSITIVITY** reveals 1/64" FBH full-scale at 2.25 and 5.0 mc/s;

**RESOLUTION** clearly defines 3/64" FBH at 3/16" at 2.25 mc/s in contact testing;

**CALIBRATED CONTROLS** make it possible to return precisely to previous conditions;



**INFINITE CHOICE OF FREQUENCIES** without tuning: broad-band receiver adapts automatically to any transducer from 0.4 to 10.0 mc/s;

**PYRAMID MARKER** with variable delay for precise interpretations with contact or immersed, angle or compression techniques.

**SIMPLIFIED CONTROLS**, lightweight (37 lbs.), and assured nationwide factory-trained service.

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11 Brown House Road, Stamford, Conn.  
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SPACE/AERONAUTICS

# on the countdown split-second communication for split-second action



Launching today's highly complex missiles demands an unprecedented degree of "team" cooperation. Hundreds of scientists, technicians and specialists must be kept constantly informed during the all-important countdown. Instant action-getting voice communications is the best answer.

An urgent call for a key man . . . an important change in fueling requirements . . . a broken control cable—all require *and get* instant action over a DuKane "job-engineered" communications system. DuKane systems are today providing these vital functions at Patrick Air Force Base, Fort Churchill, and White Sands.

DuKane's advanced engineering group, backed by more than 36 years of specialized experience in the communications field, is available to help you plan your system. Their experience is your guarantee of the best in communications.

*For any missile base ground communications need, write or wire DuKane Corporation, Department SA-6, St. Charles, Illinois.*

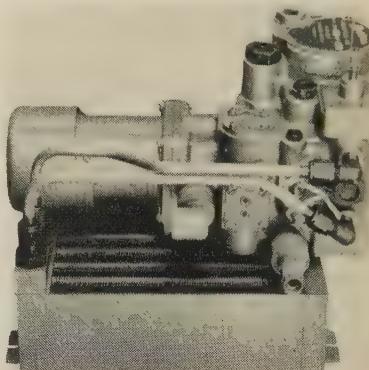
And, if you specify electronic equipment, ask for DuKane's Electronic Equipment Symbols wall chart . . . no obligation of course. DuKane products are installed and serviced by a nationwide organization of factory-trained experts.

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CORPORATION  
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Job-engineered sound installations . . . Flexifone intercom systems . . . Private automatic telephone systems . . . Hospital communications systems . . . Ionovac hi-fi tweeters and ultrasonic generators . . . Sound slidefilm projectors for education and industry . . . Electronic production facilities for industry and for defense.

Write in No. 209 on Reader Service Card at start of Product Preview Section

**COOLING SYSTEM**  
for electronic tubes



This unit, Model E/HT-200, Type 204A, for liquid cooling of high powered electronic tubes in missile guidance systems is a complete assembly, weighing about nine pounds. It measures 9½x6x7 in. It has an operating temperature range from -65 to +160 deg F, says Eastern Industries, Inc., Dept. S/A, 100 Skiff St., Hamden, Conn.

The unit has a capacity of 1600 W and operates on 28 V dc. The coolant is ethylene glycol-water solution delivered at 0.6 gpm flow rate and 35 psi pressure at maximum temperature.

Write in No. 407 on Reader Service Card

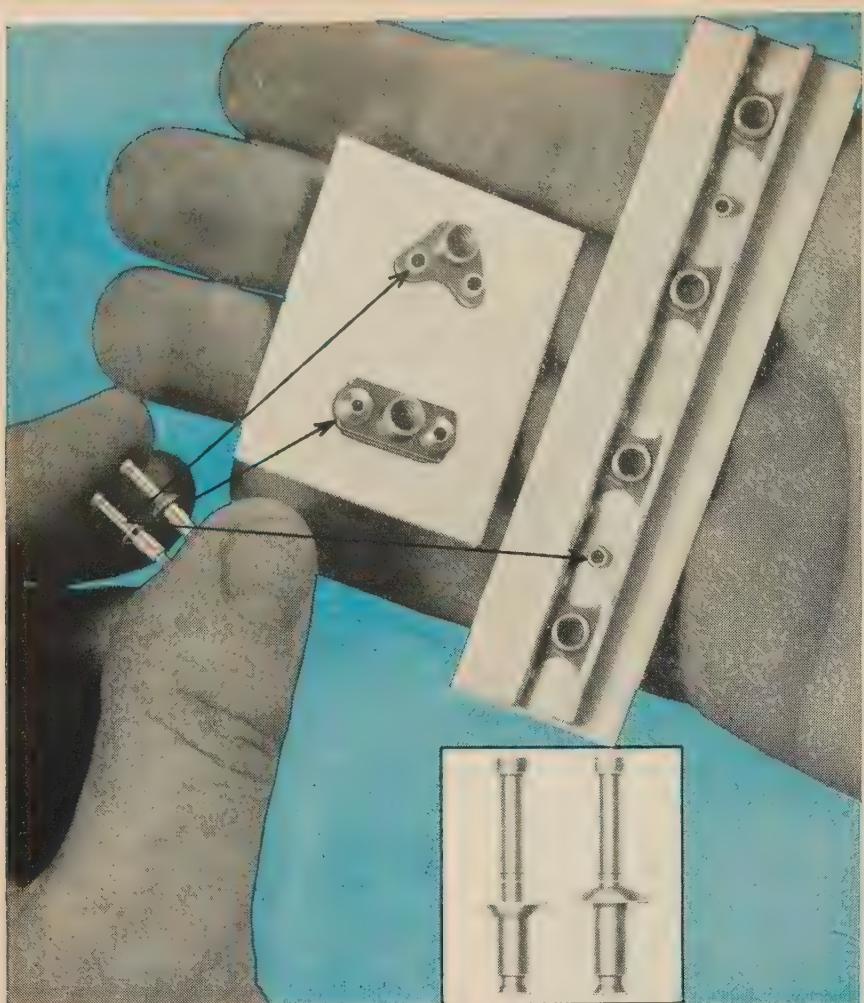
**THERMAL RIBBON**  
for high temperature use



This newly-developed Thermal-Ribbon, Model S6A, for temperature measurement and control applications to 260 deg C is available from stock from Minco Products, Inc., Dept. S/A, 740 Washington Ave., North, Minneapolis 1, Minn. Flexible, less than 0.020 in. thick, it measures ½ in. by four inches and is furnished with pressure-sensitive tape for installation to flat, curved or irregular surfaces.

Resistance is 676 ohms at 25 deg C, varying at a rate of 3.06 ohms per degree from -60 to +260 deg C per degree at 25 deg C. A calibration is furnished with each ribbon for quick conversion of resistance measurements to temperature.

Write in No. 408 on Reader Service Card  
more on page 328



For those "impossible" installations

## Cherry Research Offers The 3/32" MONEL Hollow Pull-Thru Rivet

Available with either universal or 100° countersunk head, the Cherry 3/32" Monel Hollow Pull-Thru Rivet has a high shear strength particularly adapted to fastening nut plates, gang channel and honeycomb materials where extremely limited space makes use of solid rivets difficult. Damage to surrounding material in these difficult spots is eliminated with the pull-thru hollow

rivet. Simplicity and speed of installation cut costs and save weight.

The new 3/32" Monel Hollow Pull-Thru Cherry Rivet can be installed with all existing Cherry Rivet guns, including the G-25 Hand Gun.

For technical information write to Townsend Company, Cherry Rivet Division, P. O. Box 2157-P, Santa Ana, Calif.

## CHERRY RIVET DIVISION

SANTA ANA, CALIFORNIA

## Townsend Company

ESTABLISHED 1816 • NEW BRIGHTON, PA.

In Canada: Parmenter & Bulloch Manufacturing Company, Limited, Gananoque, Ontario  
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## How Superior Breaks the Spec Barrier in Stainless Hydraulic Tubing

Just meeting specifications isn't enough when you are producing stainless steel aircraft hydraulic tubing. More and more customers are asking for and getting "above normal specification" tubing from us, even though we now produce to 18 current MIL, AMS and AN Specifications.

Here are just a few of the *extras* requested by Superior customers in recent orders:

**EXTRA LOW DEFECT LEVEL.** We satisfied requirements by special production, verified by Eddy current inspection, the tubing being below .065 in. wall.

**SPECIAL SPRING-BACK CHARACTERISTICS.** Customer's requirements were met by producing the tubing to limited cold-worked temper range.

**RESTRICTED MICROINCH FINISH LIMITS.** Special drawing procedures

and surface roughness inspection were used to achieve the finish required by the customer.

It is usual for Superior to do the unusual, since it is the world's most experienced producer of small-diameter tubing and has the widest range of analyses and sizes, plus the specialists to help solve puzzling tubing problems.

If you have a problem involving high-quality aircraft tubing and want the best combination of physical and mechanical properties, including high strength, ductility, fatigue and corrosion resistance, and good working qualities, consult us. We specialize in Seamless and Weldrawn® stainless steel aircraft hydraulic tubing in AISI Types 304, 321 and 347 in sizes ranging from .012 through 1.125 in. OD. Ask for Catalog 21, Superior Tube Company, 2038 Germantown Ave., Norristown, Pa.

# Superior Tube

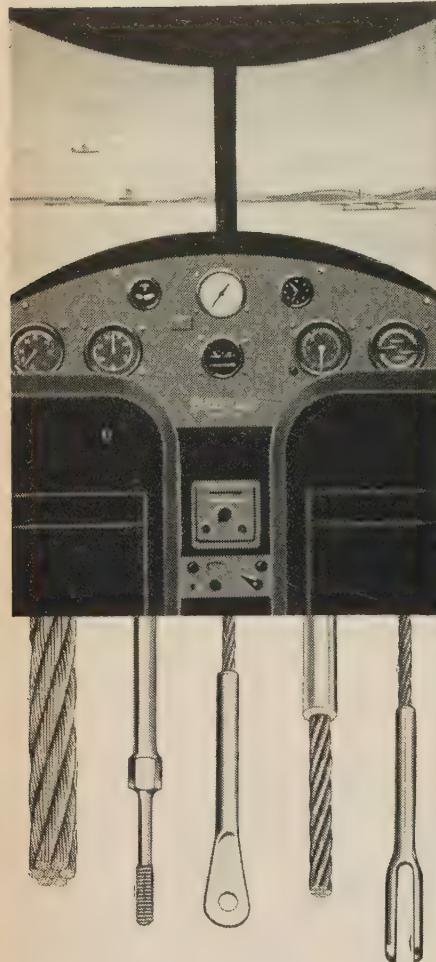
The big name in small tubing  
**NORRISTOWN, PA.**

*All analyses .010 in. to  $\frac{5}{8}$  in. OD—certain analyses in light walls up to 2 $\frac{1}{2}$  in. OD*

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

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# "Information Center" for Roebling Aircord



Here is where the immediate response of Roebling Aircord is felt. Roebling Aircord — tinned, galvanized carbon and stainless — is made to exceed *military* specifications.

Roebling Aircord is made in a full range of sizes and constructions. Cord can be furnished in stock lengths or in complete assemblies...fittings are available for every requirement. Lock-Clad, preformed cable with aluminum tubing swaged around it, is also produced by Roebling...the original producer, and for many years the only producer.

For further information on Roebling Aircord, write to Wire Rope Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

**ROEBLING**

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Subsidiary of The Colorado Fuel and Iron Corporation

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328

## PRODUCT PREVIEW

### PRESSED GLASS seals to steel

A pressed and sintered glass that can be sealed directly to stainless steel is composed of multiform glasses made from minute glass particles pressed to shape and then fired at high temperatures. The Code 9019 Multiform glass can be hermetically fused to 430 Ti and 446 stainless in a low-compression type seal, says Corning Glass Works, Dept. S/A, Corning, N. Y.

The process permits intricate shapes, holes and small radii to be formed economically in glass. The parts retain the thermal endurance, corrosion resistance and dielectric strength of the parent glass, it is said.

Write in No. 409 on Reader Service Card

### TEFLON TERMINALS are tiny



Three new types of Press-Fit teflon terminals are remarkably versatile, claims Sealectro Corp., Dept. S/A, 610 Fayette Ave., Mamaroneck, N.Y.

The first, RDT-SM-1 TUR-C1, is a reversed-mounting standoff having a body diameter to fit into a 0.100 in. chassis hole, and provided with a turret lug to simplify soldered connections. The second, FT-SM-702, is a sub-miniature feedthru with a holed turret lug to facilitate feedthru and wrapped connections in small assemblies. It fits into a 0.125 in. dia hole. The third, FT-SM-703, is a larger version of the second, providing a sturdier holed turret lug to take heavier wires, and also fits a 0.125 in. dia hole.

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### TRANSISTORS use "mesa" design

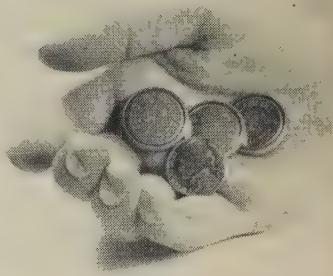
Germanium, diffused-base "mesa" transistors feature alpha cutoff frequencies up to 750 mc and power dissipations of 750 mw. With current gains of 12, 10 and 8 db at 100 mc, these new P-N-P devices operate at junction temperatures up to 100 deg C with 750 mw power dissipation at 25 deg C case temperatures, says Texas Instruments, Inc., Dept. S/A, P.O. Box 312, Dallas, Tex.

All units exceed the Mil-T-19500A

specifications. Every unit is 100 per cent production-stabilized at temperatures well above the rated 100 deg C operating temperatures. The transistors are enclosed in welded JETEC TO-5 outline package. Type designations are 2N1141, 2N1142, 2N1143.

Write in No. 411 on Reader Service Card

### BUTTON CELLS are nickel-size



Two new button cells, VO.180 and VO.100, for minimum power requirements in electrical and electronic applications, weigh a quarter of an ounce, measure  $\frac{1}{8}$  in. in diameter and are slightly thicker than a five-cent piece. The hermetically sealed units, in addition to rechargeability and long-life, are maintenance-free, non-gassing upon recharge, require no filling or electrolyte, operate at normal temperature ranges, are of rugged construction, and have a low internal resistance allowing discharge currents up to ten times capacity, says Gulton Industries, Inc., Dept. S/A, 212 Durham Ave., Metuchen, N.J.

One of the most important features, it is said, is their ability to be combined into a powerful battery. Batteries of any desired voltage in a compact cylindrical stack can be supplied.

Write in No. 412 on Reader Service Card

### ACCELEROMETER is transistorized

Closing contacts at predetermined velocities and providing analog outputs relative to acceleration and velocity are functions of a transistorized integrating accelerometer used in several missile and aircraft programs, says Donner Scientific Co., Dept. S/A, Concord, Calif. Velocity contacts can be closed at speeds up to 50,000 ft/sec, with up to 0.25 per cent accuracy over extended operational periods.

Pressure range is zero to 35 psia and temperature range is 30 to 150 deg F. Acceleration ranges extend from  $\pm 1$  to over  $\pm 20$  g. The four-lb device is designed to withstand short shock pulses of 75 G and long pulses of 50 G.

Write in No. 413 on Reader Service Card  
more on page 330

SPACE/AERONAUTICS

# WITH THE FUTURE

IN WINDS



Land-Air Inc.



#### RESEARCH & ENGINEERING

Engaged in the development of precision electronics, electrical and electro-mechanical equipment, instruments and controls embodying allied physical sciences and arts.

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Production in mass quantity of complex devices to the highest standards of industry.

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A line of products having wide utility of application in the new era of missiles, aeronautics, automation, radiology and nuclear science.

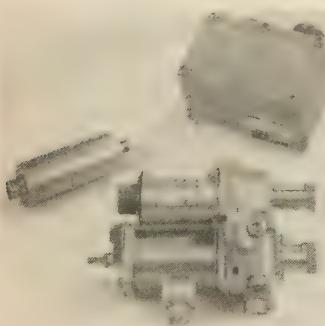
#### FIELD SUPPORT

Experienced engineers and technicians deployed worldwide in the fulfillment of engineering and end product application.

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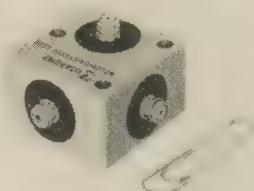
**THRUST CONTROL**  
is electro-hydraulic

This Electro-Hydraulic Thrust Control is a closed loop metering device for metering hydrogen peroxide to rocket engines used as auxiliary power plants on manned aircraft or in guided missile application. The complete control system weighing 7.3 lb includes a magnetic amplifier, pressure transducer and metering valve assembly. By its use, hydrogen peroxide flow is modulated to maintain a steady pressure level in the main rocket thrust chamber. The level of thrust can be varied as a function of an external electrical command signal, says Bendix Aviation Corp., Dept. S/A, South Bend, Indiana.

The hydraulic section of the con-

trol is designed for use of 90 per cent hydrogen peroxide and only two lines are required to connect this system to the rocket engine.

Write in No. 417 on Reader Service Card

**ACCELEROMETER**  
measures  $\frac{5}{8}$  cu. in.

Simultaneous measurement of vibration in three axes is accomplished with this Endevco Model 2223 Tri-Axial Accelerometer. Three Piezite type 1 sensing elements are mounted in mutually perpendicular planes within a  $\frac{5}{8}$  cu in. block weighing 1.4 oz, says Endevco Corp., Dept. S/A, 161 E. California Blvd., Pasadena, Calif.

The unit has a first resonant frequency of 30 kc, sensitivity of five pk-mv/pk-g plus a dynamic range of

1,000 g's with less than five per cent cross-axis sensitivity. It operates from  $-65$  to  $+220$  deg F with maximum change in sensitivity of  $\pm 10$  per cent. Frequency response is two to 2,000 cps  $\pm 5$  per cent with a 1,000 megohm load. Each separate axis is calibrated 20 to 4,000 cps  $\pm 5$  per cent before installation.

Write in No. 418 on Reader Service Card

**CHECK VALVE**  
uses plastic washer

These miniaturized check valves are for small, light, low pressure drop, high pressure requirements. They are no larger than AN or MS fittings. A sealing method incorporating a sharp-edged, non-flowing, plastic material as a washer, inserted in the valve poppet, seals against the conical seat and makes an "inseparable assembly", says Integral Corp., Dept. S/A, 100 Frank Rd., Hicksville, N. Y.

They are applicable to hydraulic, pneumatic, and fuel systems operating within the temperature range of  $-65^{\circ}$  F to  $700^{\circ}$  F and operating pressures up to 5000 psi. Cracking pressure can be set as low as 2 psi.

Write in No. 419 on Reader Service Card

more on page 334

# BENDIX SR RACK AND PANEL CONNECTOR

*with outstanding resistance  
to vibration*

The Bendix type SR rack and panel electrical connector provides exceptional resistance to vibration. The low engagement force gives it a decided advantage over existing connectors of this type.

Adding to the efficiency of this rack and panel connector is the performance-proven Bendix "clip-type" closed entry socket. Insert patterns are available to mate with existing equipment in the field.

Available in general duty, pressurized or potted types, each with temperature range of  $-67^{\circ}$  F to  $+257^{\circ}$  F.

Here, indeed, is another outstanding Bendix product that should be your first choice in rack and panel connectors.



**SCINTILLA DIVISION**  
SIDNEY, NEW YORK



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# a new, improved ALODINE for aluminum

**IN LESS TIME**—ALODINE 1200S provides increased chemical activity for dramatic reduction in processing time . . . up to 50% in most cases! You get far faster processing than ever before, with the same high quality protection!

**WITH LESS EQUIPMENT**—You can install an ALODINE 1200S system quickly and conveniently, *without resorting to mechanical bath maintenance!* That means no dangerous, time consuming checking routines with the possibility of bath contamination always present!

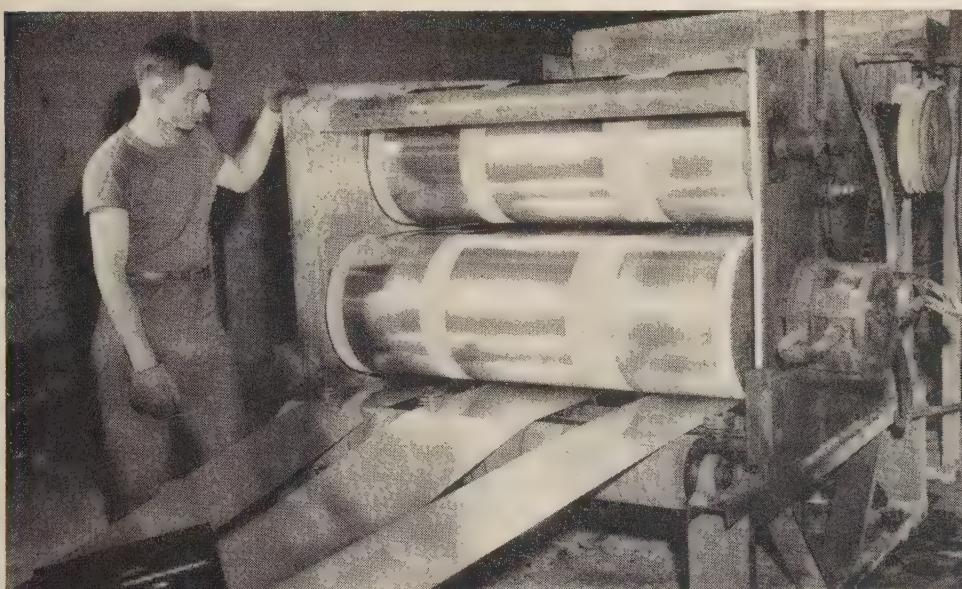
**AT LESS COST**—ALODINE 1200S can be processed through continuous dip in the same time cycle other conversion coatings require for continuous spray lines! This dip technique reduces initial equipment costs, slashes maintenance costs to a minimum and allows aluminum fabricators to utilize conversion coatings more frequently for a wider

*Cost Saving,  
Time Saving  
ALODINE 1200S  
Pre-Paint Treatment  
Protects Aluminum  
Best!*

range of product applications! Whatever the application method—brush, dip, continuous strip or spray—ALODINE 1200S may be the answer to your production problems.

**FOR MORE FLEXIBILITY**—Most important, its ease of operation, safety in use and versatility enables ALODINE 1200S to answer one of the most perplexing problems inherent in providing corrosion protection and paint bonding qualities for aluminum—the problem of constant, uniform quality. ALODINE 1200S is qualified under Government Specification MIL-C-5541.

*Investigate cost saving, time saving ALODINE 1200S today! And whenever you have a chemical finishing requirement for aluminum—any type of aluminum—there's an ALODINE process available to protect or decorate the metal, and anchor the paint finish more securely.*



Typical ALODINE 1200S strip line installation at ALSCO, INC. Strip from aluminum coil is fed into Alodine processing baths where it is cleaned, rinsed, deoxidized, rinsed, coated with ALODINE 1200S, rinsed and given a final acidulated rinse. Strip is then rewound, roll coat painted, roller formed into final shape, backed, inspected and packed for final shipment.



## ALODINE 1200S

another chemical development of **AMCHEM PRODUCTS, INC., Ambler 10, Pa.**  
(Formerly American Chemical Paint Co.)

Write for Bulletin 1424A  
describing use of Alodine  
for aluminum fabrications  
of all types.

Detroit, Mich. • St. Joseph, Mo. • Niles, Calif. • Windsor, Ont. Amchem and Alodine are registered trademarks of Amchem Products, Inc.

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*"Up  
to your neck  
in  
Ground Support  
Equipment  
problems?"*

## You can turn your toughest GSE problems over to **Hamilton Standard division of United Aircraft Corporation**

Hamilton Standard has expanded its Ground Support Equipment Department, making available to the entire aircraft and missile industry its skilled personnel, technical "know-how" and complete, modern facilities. Hamilton Standard has capabilities for solving virtually all GSE problems—from initial design concept through production and system man-

agement, from tools and equipment to fixed facilities.

More than 40 years experience and a highly competent organization with unusual skills and facilities—backed by the services and resources of United Aircraft Corporation—provide first-line qualifications and capabilities in the GSE field. For further information contact:

GROUND SUPPORT  
EQUIPMENT DEPARTMENT



**HAMILTON STANDARD**

A DIVISION OF UNITED AIRCRAFT CORPORATION

Windsor Locks, Connecticut

SPACE/AERONAUTICS

# stitching together a giant radome



*Radome designed and built by Long Sault Woodcraft Limited, St. Andrews East, Quebec, for the United States Air Force RADC.*



*Looking upward from the inside of the world's largest stressed skin sandwich radome built of translucent fiberglass panels, securely joined by hundreds of DUAL-LOCK fasteners.*

Radar antennae along the upper perimeter of North America's defense system are enclosed by protective domes which stop ice, snow, and gales up to 150 mph.

This precisely engineered pattern of fiberglass panels is erected quickly and surely, under the most adverse field conditions, using recessed Simmons DUAL-LOCK fasteners.

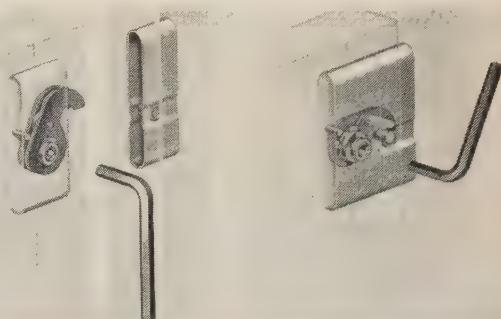
DUAL-LOCK is ideally adapted to panel fastening for military shelters, demountable shipping containers, aircraft cowlings and guided missiles.

#### Features:

- High load characteristics. The standard No. 1 DUAL-LOCK withstands 2500-lb. tension, and with modifications, tension loads of 7000 lbs. and over.
- Double-acting take-up provides great closing pressure, with minimum pressure on operating tool.

- Positive-locking. Trigger action insures fully open and fully closed positions.
- Vibration-proof and impact-proof. Will not accidentally unlock or loosen.

**Write for catalog #1257.** Complete specifications, drawings, details of DUAL-LOCK and other Simmons Fasteners with unlimited money-saving applications.



## SIMMONS FASTENER CORPORATION

1760 North Broadway, Albany 1, New York

See our catalog in Sweet's Product Design File

QUICK-LOCK • SPRING-LOCK • DUAL-LOCK • ROTO-LOCK • LINK-LOCK • HINGE-LOCK

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# NEW ALINA DIAL COMPARATOR SET NO. 99

With dependable  
3 point  
Centralization

**The 3 purpose instrument with unlimited application  
in your inspection department**

Use as Dial Indicator graduated to read in .0001".

Use as Bore Gage covering a range of .200" thru  
.5090" and reading in .0001".

Use as Dial Test Indicator graduated in .0005".

The No. 99 incorporates a high quality dial indicator together with all the necessary gage heads and extensions. It may be used directly at your machines or clamped to your fixtures. Furnished in handsome plush-lined case.

Dial Test Indicator Set No. 98, a modification of the No. 99, is especially designed for applications where measurements must be taken in deep holes, slots, etc. Write for detailed brochure.



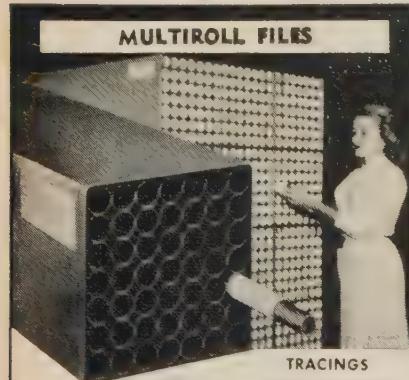
WRITE FOR ILLUSTRATED LITERATURE.

## ALINA CORPORATION

122 East Second Street, Mineola, Long Island, New York

Alina Corporation, 853 East 8 Mile Road, Detroit 20, Michigan

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### MULTIROLL FILES

TRACINGS  
PRINTS • SHEET MATERIAL

### QUICK, FILING AND WITHDRAWAL

Depth	11 <sup>1</sup> / <sub>4</sub> "	22 <sup>1</sup> / <sub>4</sub> "	30 <sup>1</sup> / <sub>2</sub> "	36 <sup>1</sup> / <sub>2</sub> "	42 <sup>1</sup> / <sub>4</sub> "
49 Tube	49AB	49CD	4930	4936	4942
1 <sup>1</sup> / <sub>4</sub> " I.D.	\$7.50	\$9.50	\$12.80	\$13.80	\$14.80
25 Tube	25AB	25CD	2530	2536	2542
2 <sup>1</sup> / <sub>4</sub> " I.D.	\$7.00	\$9.00	\$11.80	\$12.80	\$13.80

#### Shipping Weight

Model 49 8 lbs. 12 lbs. 15 lbs. 18 lbs. 20 lbs.

Model 25 6 lbs. 10 lbs. 13 lbs. 15 lbs. 17 lbs.

ENAMELED DARK GREEN OR MED. GRAY - State Color



JR 36

Designed to  
Mount Under  
Board—Mounting  
Brackets  
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Gray Only.



9.50  
SET OF TWO  
8 lbs. 3<sup>1</sup>/<sub>2</sub> w.

Sold in Sets Only—  
2 JR36 Per Set

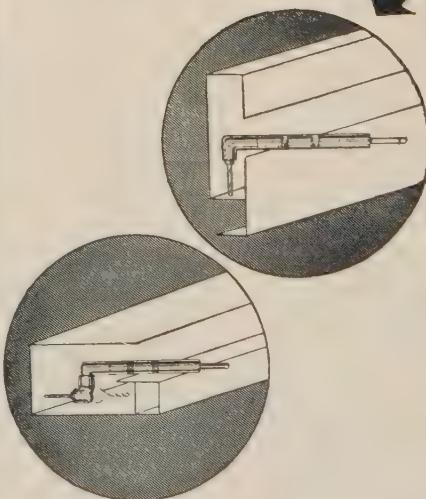
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F.O.B. St. Clair Shores, Mich. • Prescott 3-2515

ROLL & FILE SYSTEMS, INC. P. O. BOX 3863-B  
DETROIT 5, MICH

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334

### FOR THESE ANGLE DRILLING APPLICATIONS



• AND MANY MORE . . . there is a  
TERRY Angle or Flexible Tool to fill  
your needs.

**TERRY**  
Angle Drilling Attachments

Folder on request

**GEORGE A. TERRY CO.**

354 S. Elmwood Ave., Buffalo 1, N. Y.

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### PM MOTOR for high temperature

This high temperature  $\pm 3$  per cent speed regulation continuous duty 1<sup>1</sup>/<sub>4</sub> in. PM governed motor with gear reduction and filter for precise timing applications is offered by John Oster Mfg. Co., Dept. S/A, 1 Main St., Racine, Wis.

Speed does not deviate, it is claimed, more than three per cent from 60 rpm with 60 oz. in. load and 24 to 29Vdc supplied under any combination of the following MIL-E-5272 environmental conditions: temperature: —55 to 12 deg C, procedure I; vibration: procedure I; shock: procedure II; acceleration: ten g, procedure I or II. Type 13R-9102-00 also meets MIL-I-6181B radio noise specifications.

Write in No. 414 on Reader Service Card

### CERAMIC FOAM has low loss

Materials in the two series of ceramic forms now available are light and can be used for temperatures above 1000 deg F, says Emerson & Cumings, Inc., Dept. S/A, 869 Washington St., Canton, Mass.

Eccofoam LM-43A is supplied at dielectric constants 1.3, 1.4, 1.5 and 1.6. Dissipation factor is below 0.001. Eccofoam WC-8 is supplied at dielectric constants 1.7, 1.8, 1.9, 2.0, 2.5, 3.0, 4.0, and 5.0. Eccofoam LM-43A materials are below 20 lb per cu ft; the Eccofoam WC-8 series varies from 20 to 70 per lb per cu ft, dependent upon dielectric constant. Flexural strength remains high, even at 1000 deg F. The forms can be fabricated readily with standard tools.

Write in No. 415 on Reader Service Card

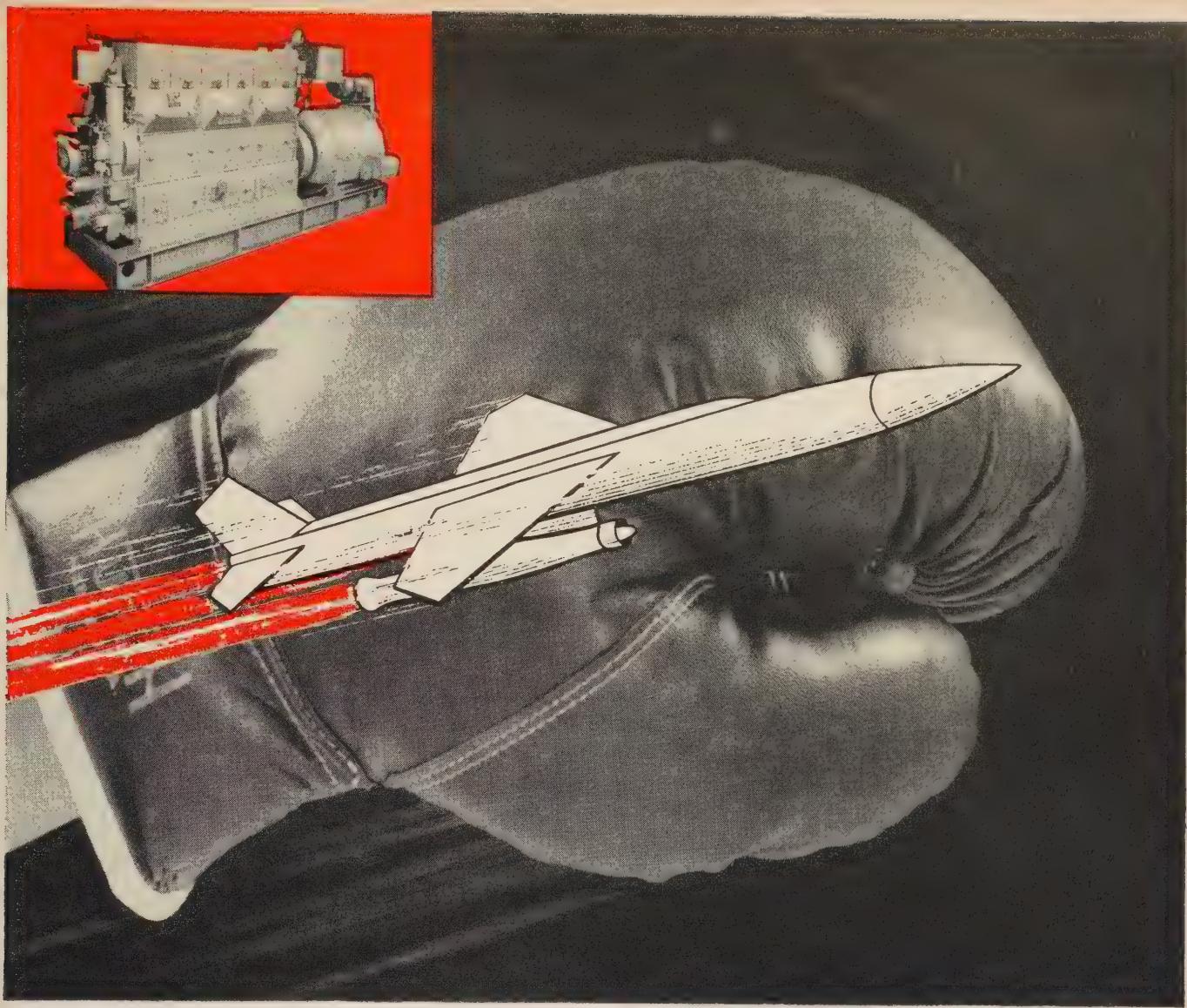
### TIME DELAY is subminiature

This new hermetically sealed thermal time delay relay is of subminiature size, has a seated height  $\frac{1}{8}$  in. above mounting panel, utilizes the principle of longitudinal expansion and is designed to withstand continuous 20 g vibration at frequencies up to 1000 cps, says G-V Controls Inc., Dept. S/A, Okner Parkway, Livingston, N.J. Contacts are spst, either normally open or normally closed. Rating is two amperes resistive at 115V ac or 28 Vdc.

Relays come in ten standard delays from two to 75 sec and for standard heater voltages of 6.3, 28, and 115V. Ambient range is up to 85 deg C for continuous energization, up to 125 deg C for energization up to three minutes. Diameter is  $\frac{3}{4}$  in.; overall body height, 1<sup>1</sup>/<sub>16</sub> in. Weight is about  $\frac{3}{4}$  oz.

Write in No. 416 on Reader Service Card  
more on page 336

SPACE/AERONAUTICS



## SUPERIOR ENGINES develop KW... for missile KO!

The warhead carries a missile's big punch, but its fighter instinct is developed by earth-bound electric power. Without reliable ground power, there could be no missile launching, guidance and control, or communication . . . and no knock-out blow!

Already in the U. S. defense ring are dependable White Superior diesel engine generator sets at BOMARC, NIKE and other missile installations. At every round, they are ready with quick, easy starting and continuous, reliable operation. Precision construction takes Superior the limit, too, with trouble-free performance, low maintenance and maximum fuel economy.

In the battle for space, Superiors are veterans, being installed on sections of SAGE, "DEW" line and the "Texas Towers." They will soon find important civilian sky duty also at many of the Federal Aviation Agency's new air-traffic control stations. White can custom-engineer engines to meet your exact needs . . . offers experience with automatic, unattended and remotely controlled operation. If your requirements range from 215 to 2150 HP, or 150 to 1500 KW, get complete information now!

### WHITE DIESEL ENGINE DIVISION

THE WHITE MOTOR COMPANY, Plant and General Offices: Springfield, Ohio

**White Diesel**



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pardon our brash phrasing

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in the use of pure dry hydrogen and nickel alloy for brazing aircraft, rocket and missile components. Our equipment is also ideally suited for bright annealing powdered metal sintering and copper brazing.

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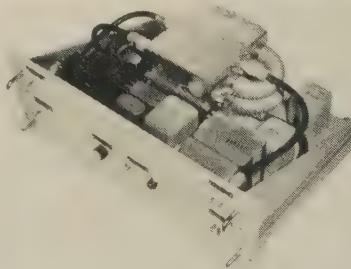
## METER for surface temperatures

An instrument for making 2% full-scale accuracy temperature measurements, the "Pyromet" comes in two types: automatically compensated for ambient temperature; non-compensated for relative temperature readings. Model DTF is an automatically compensated type in ranges 0-300, 0-450, and 0-650F. The non-compensated type, model ETF, is available in the 0-200 C range only, says Royco Instruments, Inc., Dept. S/A, 874 Fabian Way, Palo Alto, Calif.

All units are self-contained and ultimate temperature response is attained in 3 to 10 sec., depending on the surface character.

Write in No. 420 on Reader Service Card

## ANTENNA MULTICOUPLER has 200-mc pass band



This antenna multicoupler will pass the frequency range between 200 and 400 mc from a single wideband antenna to four separate-channel receivers. By cascading multicouplers, the same antenna will feed additional receivers. This one-antenna operation eliminates the difficulties common to multi-antenna installations, says Resdel Engineering Corp., Dept. S/A, 330 S. Fair Oaks, Pasadena, Calif.

Used as a laboratory wideband amplifier, the multicoupler will feed signals of one signal generator to four independent RF amplifiers or receivers. Isolation between outputs is 45 db minimum. Gain is 10 db for each channel and uniformity of response is  $\pm 2$  db. The unit has an integral power supply and is packaged for standard rack mounting.

Write in No. 421 on Reader Service Card

## ATC TRANSDUCERS withstand 2000 deg F

These high temperature ATC Differential Transformers, Type 6208 HHK and Type 6206 HHK, are available for prototype and model evaluation. They are able to operate continuously at 1000 deg F and to withstand 2000 deg F for periods up to five minutes, says Automatic Timing & Controls, Inc., Dept. S/A, King of Prussia, Pa.

Wound on specifically designed ceramic bobbins, leads are terminated on lugs for secure connections. Lead-wires, fish-spline insulated, are supplied up to three feet long. The 6208 HHK is for linear displacement measurements up to  $\pm 0.150$  in.; type 6206 HHK is for displacements up to  $\pm 0.500$  in.

Write in No. 422 on Reader Service Card

## SERVO VALVE is miniature



The Model 410 Miniature Hydraulically Servovalve features excellent reliability, says Raymond Atchley, Inc., Dept. S/A, 2340 Sawtelle Blvd., Los Angeles 64, Calif. The reason for this, they claim, is that the servovalve first and second stages can receive and pass on particles as large as 200 microns without malfunctioning; and the first stage hydraulic preamplifier has only one source of oil and, therefore cannot become unbalanced due to oil contamination.

The valve features a frictionless high-gain push-pull force feedback servo that controls the second stage. The hermetically sealed torque motor is dry. It has low hysteresis of one per cent; resolution, 0.1 per cent. Maximum flow ranges from  $\frac{1}{2}$  to five gpm with 1000 psi drop. Operating pressures are from 300 to 3000 psi. Weight, 11 oz.

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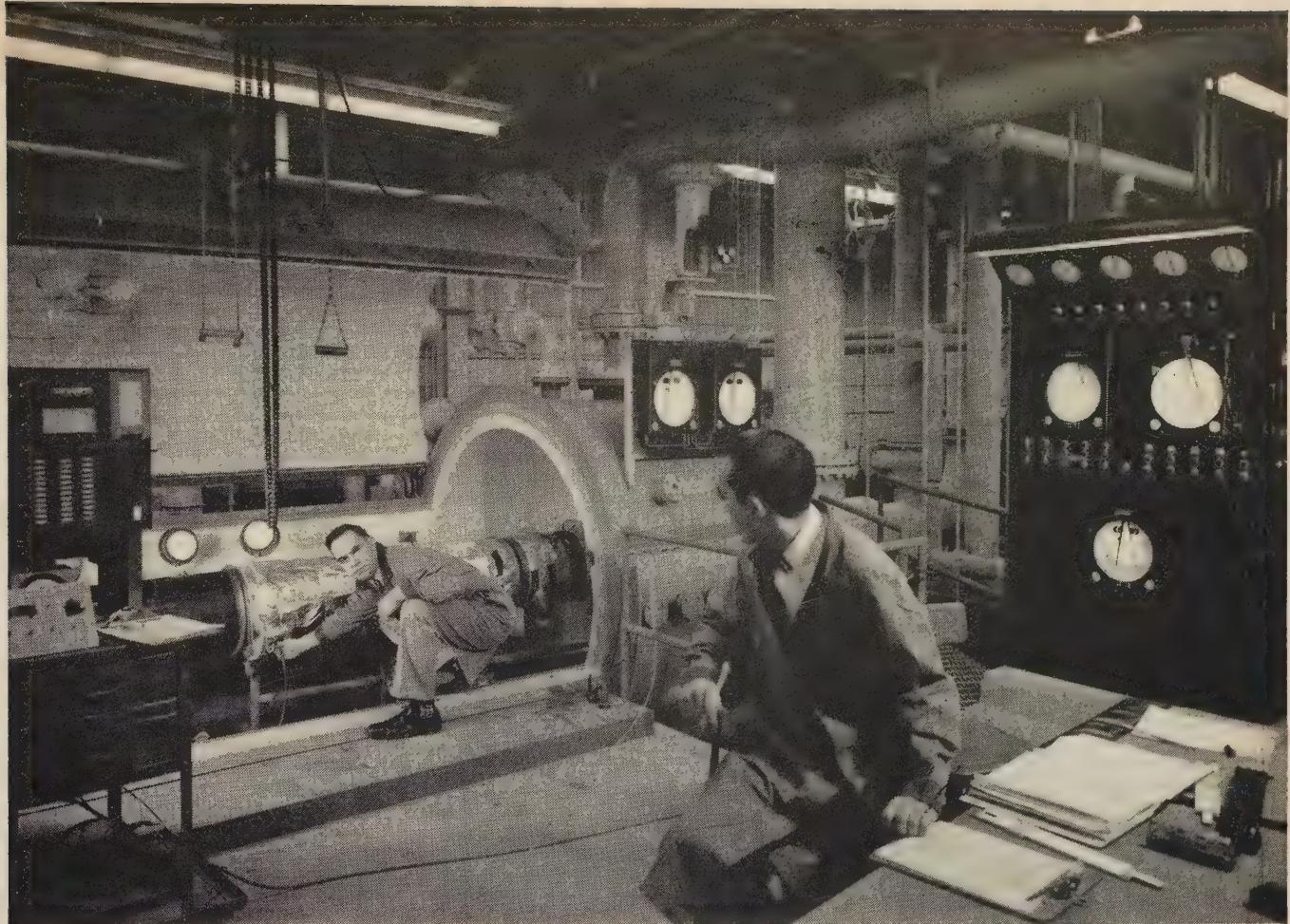
## MAGNETIC SWITCH is hermetically sealed

This spst magnetically actuated switch, DC-01, is filled with hydrogen and hermetically sealed in glass. The stationary unit is actuated by a  $\frac{1}{16}$  oz. moving alnico magnet. It will operate in any position. It has indefinite shelf life, visible contacts and operates noiselessly, says Hamlin, Inc., Dept. S/A, 1316 Sherman Ave., Evanston, Ill.

The switch is  $\frac{1}{8}$  in. long with a  $\frac{1}{4}$  in. diameter. It is rated at 125 V,  $\frac{1}{4}$  ampere, ac, and will operate under high and low pressure over a range of -85 to 350 deg F. It may be used in explosive or corrosive atmospheres. Laboratory tests indicate trouble-free operation in excess of ten million.

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more on page 338

SPACE/AERONAUTICS



## *Birth of a Notion*

To reduce the weight of heat exchangers—to test new structures—to handle hotter gases and higher temperature differentials—to make paper-thin metal sheets function without fail—these are some of the basic questions which Janitrol is uniquely qualified to ask . . . and answer.

Some of the answers are coming from Janitrol's high-altitude, low temperature test chamber, shown above. One of the few privately owned facilities of its kind in the aviation industry, this large chamber is able to simulate 100,000 foot altitude conditions at  $-65^{\circ}$  F, while simultaneously dissipating a million Btu per hour from the equipment on test.

This is just one aspect of Janitrol's unique capabilities in building reliability into heat exchangers, couplings, pneumatic controls, and related hardware—and undertaking major research and development projects, as well.

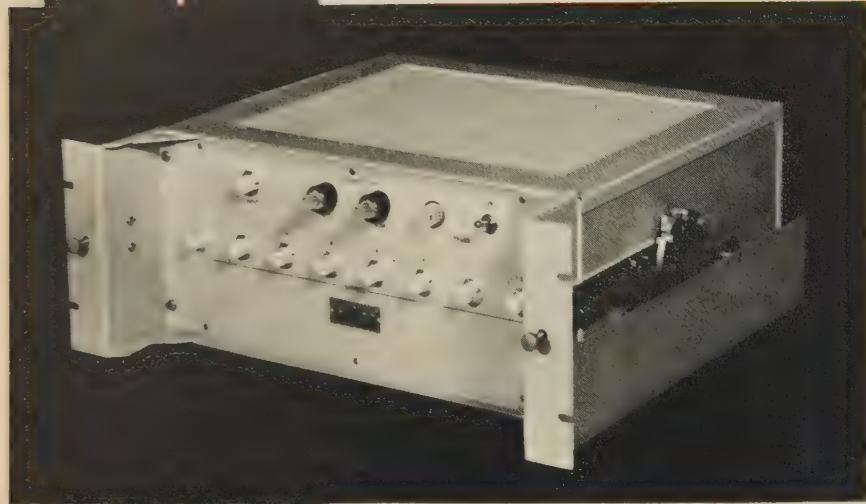
Ask your Janitrol representative or write us for your copy of "Janitrol Resources," a well documented report of our capabilities. Janitrol Aircraft Division, Surface Combustion Corporation, Columbus 4, Ohio, Broadway 6-3561; Ft. Worth, Walnut 6-3386; Hollywood, HOLlywood 3-6861; Washington, D. C., OLiver 4-2171; Philadelphia, MIDway 2-6342.

pneumatic controls • duct couplings and supports • heat exchangers • combustion equipment for aircraft, missiles, ground support

**JANITROL**

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**NEMS · CLARKE**  
**PM-406**  
**PREAMPLIFIER-**  
**MULTICOUPLER**



**T**HE PM-406 is a combination instrument comprised of a preamplifier and multicoupler located on a single chassis for rack mounting. This unit permits the coupling of eight receivers to a single antenna and is designed for use where short runs of cable from the antenna are employed. These units are of the "bath tub" chassis design having a 3-inch recessed front panel to permit patching cables to hang without protruding. Modifications of this design are available on special order.

#### SPECIFICATIONS

Pass Band .....	215-260 megacycles
Uniformity of Response .....	Within 3db
Gain .....	22db (approximate)
Impedance ...	Designed to operate in a 50-ohm system
Inputs .....	1
Outputs .....	8
Noise Figure .....	Less than 4.5db
Isolation between outputs .....	37db minimum
Size .....	19" x 7" x 16½"

**NEMS · CLARKE CO.**

A DIVISION  
OF VITRO  
CORPORATION  
OF AMERICA



919 JESUP-BLAIR DRIVE  
SILVER SPRING, MARYLAND  
MUNICIPAL AIRPORT  
MARTINSBURG, WEST VIRGINIA

PRECISION ELECTRONICS SINCE 1909

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**PRINTED CIRCUIT LAMINATE**  
*is flame-resistant*

This flame-resistant laminated plastic for printed circuit applications, Phenolite grade XXXP-475, offers excellent electrical properties, very high insulation resistance, low moisture absorption, exceeding all NEMA requirements and yields excellent punching results with a minimum of heating in the range of 130 to 150 F. For applications where fire must be considered, the material offers two advantages: grade XXXP-475 is self-extinguishing and prevents spread of flame; affords the same flame resistance as paper base epoxy grades but at cost reductions of about 40%, says National Vulcanized Fibre Co., Dept. S/A, 1059 Beech St., Wilmington 99, Del.

Applications include computers and aircraft.

Write in No. 425 on Reader Service Card

**FLOW CONTROL VALVES**  
*reduced in size*

The FC-30 Series flow control servo valve is a smaller, lighter version of the FC-2 valve, which is used extensively in missiles and high performance aircraft, says Cadillac Gage Co., Dept. S/A, Costa Mesa, Calif. An FC-30 valve that is equal in capacity to the FC-2 has a 25 per cent smaller unit volume and is  $\frac{1}{6}$ th lighter.

The standard FC-30 weighs 14.5 oz, measures 1.75x2.00x2.8 in. Available valves cover the flow range from 0.15 to 13 gals/min. Internal leakage is 0.09-gpm maximum for a four-gpm valve at neutral position, using Mil-O-5606 hydraulic fluid at 90 deg F and 3000 psi supply pressure. Supply pressure operating range is 500 to 4000 psi.

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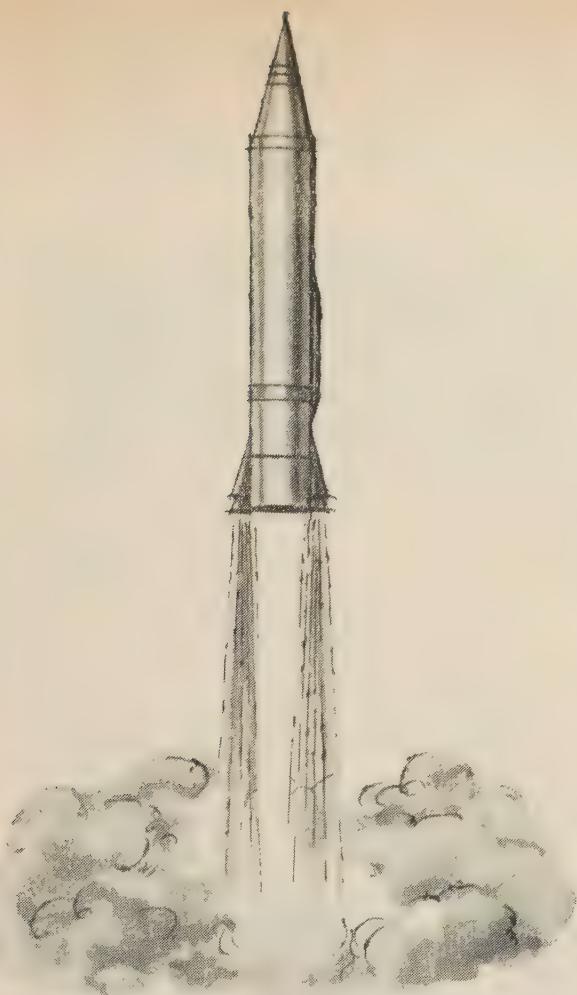
**FLEXIBLE CONDUIT**  
*has polyvinyl jacket*

Three types of Liquatite flexible conduit, one of which can withstand temperatures up to 220 deg F, are being offered by Electric-Flex Co., Dept. S/A, P.O. Box 128, Roselle, Ill. All three types are made from heavy, spirally-wound square-locked galvanized metal and are either cord or wire packed for consistent bending diameters.

An extruded polyvinyl jacket protects wiring from oil, chemicals, water, corrosive fumes, and other injurious conditions. Type L.A. has a continuous copper wire incorporated in the core. Type H.T. is the 220-deg conduit, and Type L.T. is a general duty type, and both meet J.I.C. specifications.

Write in No. 427 on Reader Service Card  
more on page 342

SPACE/AERONAUTICS



## QUALITY OF "MINUTEMAN" MISSILES PARTS DETERMINED BY STANDARD STEEL WORKS RESEARCH

Months of research and development of various rigid quality-control procedures at Standard Steel Works Metallurgical Laboratories preceded the delivery of "Minuteman" missiles parts of extremely high-quality material.

Standard Steel Works' laboratory facilities—second to none in industry—make possible delivery of unusual forgings from special steel alloys in record time. Missiles parts of the highest cleanliness ratings have been furnished from both air and vacuum melted steel. All are subjected to ultrasonic inspection under water for defects and to microscopic examination for cleanliness.



**First stage** motor case ring—vacuum-melted D6A steel



**Second stage** motor case ring—vacuum-melted 300M steel



**Third stage** motor case ring—air-melted AMS-256 steel

## Standard Steel Works Division BALDWIN · LIMA · HAMILTON

BURNHAM, PENNSYLVANIA

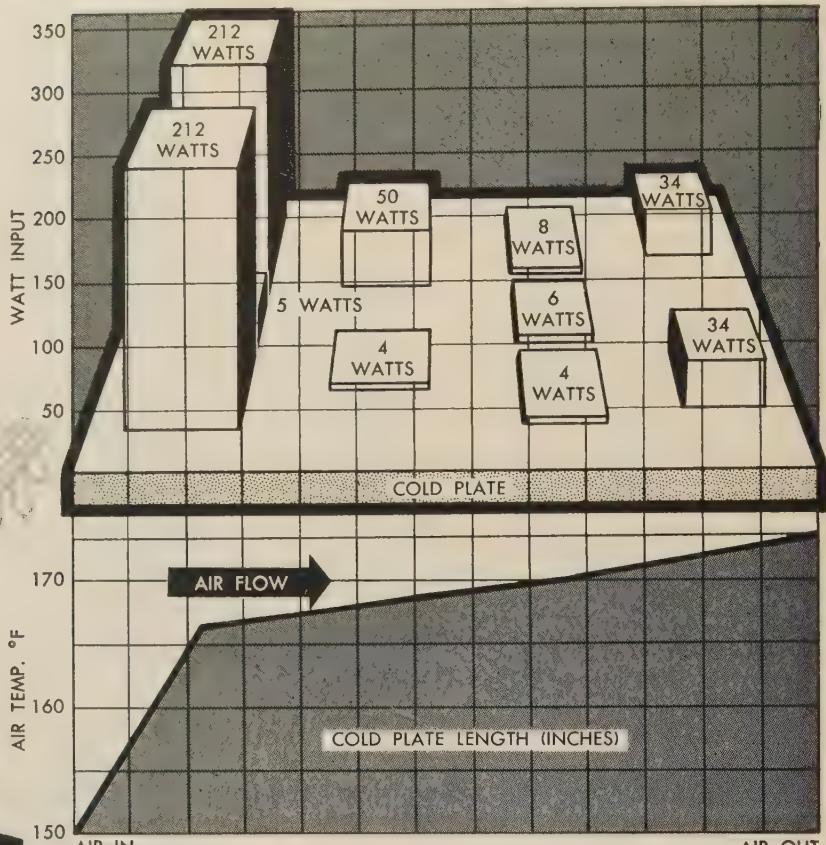
Rings • Shafts • Car wheels • Gear blanks • Flanges • Special shapes



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# ELECTRONIC COOLING

**Requirement:** Stay within customer's envelope. Dissipate 569 watts thru 13 x 10 in. cold plate and not exceed a plate temperature of 173°F with cold plate air-in temperature of 150°F. Provide areas for circuits to be mounted to cold plate surface between power units.



**Answer:** UAP cold plate configuration designed to provide adequate heat transfer from localized high, medium and low heat concentration areas with air-in temperature at 150°F. All requirements met with room to spare.

The hypothetical conditions as stated above are typical of the problems that have come to us since the advent of electronically controlled supersonic missions.

UAP eminence in the heat exchanger field has been firmly established over the years by delivery of systems and components of proved optimum performance and reliability. Our experience covers the engineering and production of devices for application as cold plates, gas-air heat exchangers, air-liquid heat exchangers, and associated controls; mechanical refrigeration systems and expendable refrigeration systems. These can function in the anticipated environmental conditions and utilize one or more of the following heat sinks; ambient air, expanded bleed air, expanded ram air, ram air, expendable refrigerant, or available liquid.

Make your requirements our responsibility. Call . . .

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OHIO .....	1116 Bolander Ave., Dayton, BA 4-3841
CANADA .....	United Aircraft Products, Ltd., 147 Hymus Blvd., Pointe Claire, P.Q., Phone Montreal: OX 7-0810



a famous family of aircraft essentials since 1929

## UNITED AIRCRAFT PRODUCTS, INC.

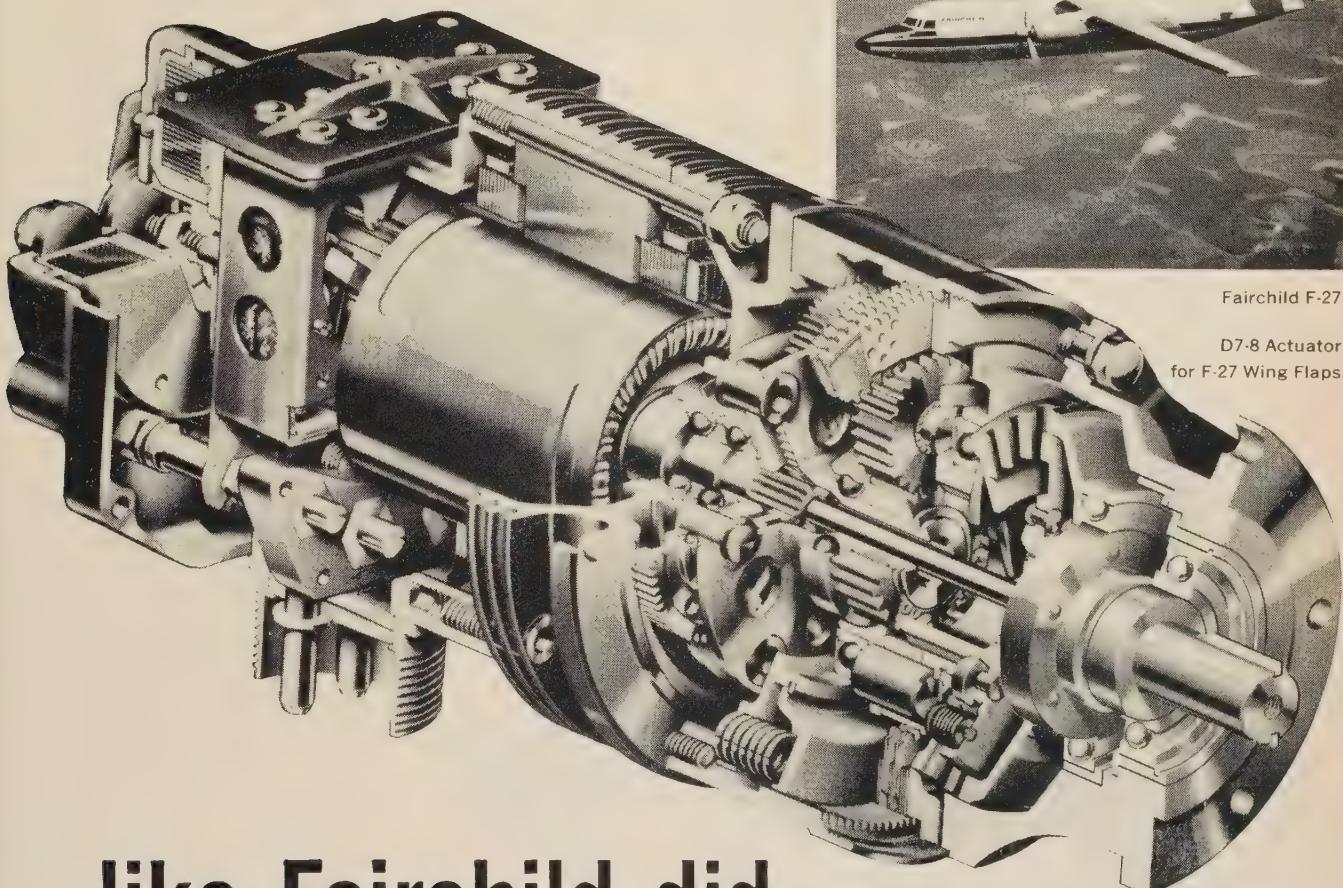
1116 BOLANDER AVENUE, DAYTON, OHIO

Circle No. 268 on Reader Service Card in Product Preview Section



SPACE/AERONAUTICS

# ACTUATE...



Fairchild F-27

D7-8 Actuator  
for F-27 Wing Flaps

...like Fairchild did  
with its F-27

Come to Jack & Heintz with your actuator problems. We will work with you, as we did with Fairchild, to research, design and produce actuators or actuator systems for aircraft, missiles and ground support. J & H offers extensive experience in systems for military aircraft . . . plus the advantages of one location for complete development and production of the design. Talk to us about electric, hydraulic, electrohydraulic, electromechanical or pneumatic systems or components for linear or rotary actuation . . . in the applications listed. Or write: Jack & Heintz, Inc., 17634 Broadway, Cleveland 1, Ohio.

**JACK & HEINTZ, Inc.**

SYSTEMS FOR AIRCRAFT, MISSILES AND GROUND SUPPORT

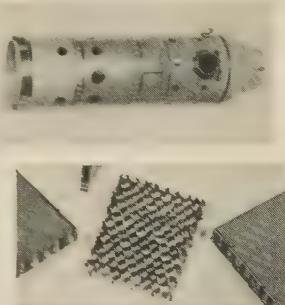
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## We Furnace Braze Stainless Alloys

To eliminate problems of distortion, stress, oxidation, and porous welds

The advantages of stainless alloy brazing in dry hydrogen & vacuum environment furnaces are many. And the use of brazing for high-temperature service parts is growing just as fast as potential users learn to design for it. We offer technical design assistance to further the acceptance of this modern joining technique. Ten years of pioneering this field, plus operating three stainless processing plants, plus manufacturing our own Nicrobraz® brazing alloys, fully qualifies us to give initial guidance to your design crew in planning brazed stainless components. Call TWinbrook 3-3800 in Detroit, or write to find out how we might help you.



### STAINLESS PROCESSING DIVISION

WALL COLUMNOY CORPORATION

19345 John R Street • Detroit 3, Michigan

There are Wall Columnoy furnace plants in Detroit, Michigan; Morrisville, Pennsylvania; and Montebello, California

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Measure liquid level of all cryogenic fluids to .050 inches with these small 5 oz. Heat Sink liquid level detectors.

They introduce no energy directly into the cryogenic medium and are compatible with hydrogen, fluorine and all cryogenic mediums.

Write for details on these liquid level detectors. Also available for cryogenic use are gas thermometer probes, grid cobalt thermocouples, cryostats and platinum probes.

**CRYOGENICS, INC.**  
P. O. BOX 1919  
POMPANO BEACH, FLA.

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Specify

**ABC**

PRECISION  
AN-NAS-MS  
BOLTS

SPECIAL  
FASTENERS

STANDARD ALLOY

SUPER ALLOY  
HI-HEAT RESISTANT

CUSTOM MFG'D.

- All bolt heads are hot forged
- All threads are rolled after heat treating
- Rockwell hardness testing and magnetic inspection insure quality products
- Each step in production guarded by statistical quality control

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SERIES

**ABC**

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701 W. Garvey Blvd., El Monte, Calif.  
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Write in No. 229 on Reader Service Card

### CIRCUIT ASSEMBLY has low noise level

With 40 circuits tied in series and with 50 ma of current flowing through this slip ring and brush assembly, the total combined noise level of the 40 slip rings and 80 brushes remains under two millivolts despite 1000 hours of operation while running at 500 rpm under vibration conditions of ten cycles per second. This low noise level was maintained despite temperatures of -65 to +300 deg F and from the starting of tests to completion of the 1000 hour life test, says Slip Ring Company of America, Dept. S/A, 5456 W. Washington Blvd., Los Angeles 16, Calif.

The breakaway friction level of the assembly is kept under 75 gram cm. It meets all requirements of MIL-5400-A.

Write in No. 433 on Reader Service Card

### STANDARD BOLTS for use up to 1600°

These first standard structural fasteners for use at temperatures up to 1600 are offered in both airframe and engine bolt configurations and are fabricated from any of four advanced metal alloys, M-252, Waspalloy, Udimet 500, and Hastalloy R-235. The development provides critical fasteners for jet engine and rocket motor operation, as well as fastenings for hypersonic airframes and missiles having extreme surface temperatures. Developed primarily for aircraft, jet engine, missile and rocket needs, the fasteners, described as "red hot in use," presumably could be applied in gas and steam turbines and related fields, says Standard Pressed Steel Co., Dept. S/A, Jenkintown, Pa.

Bolts are rated at minimum tensile strength of 135,000 psi at 1200°.

Write in No. 434 on Reader Service Card

### ACCELEROMETERS are ungrounded

Ungrounded piezoelectric accelerometers that are designed to eliminate the problems of circulating ground currents have been announced by Gulton Industries, Inc., Dept. S/A, 212 Durham Ave., Metuchen, N.J. The Glennite units are produced in four classes, including unidirectional, tridirectional, high temperature, and extra high temperature.

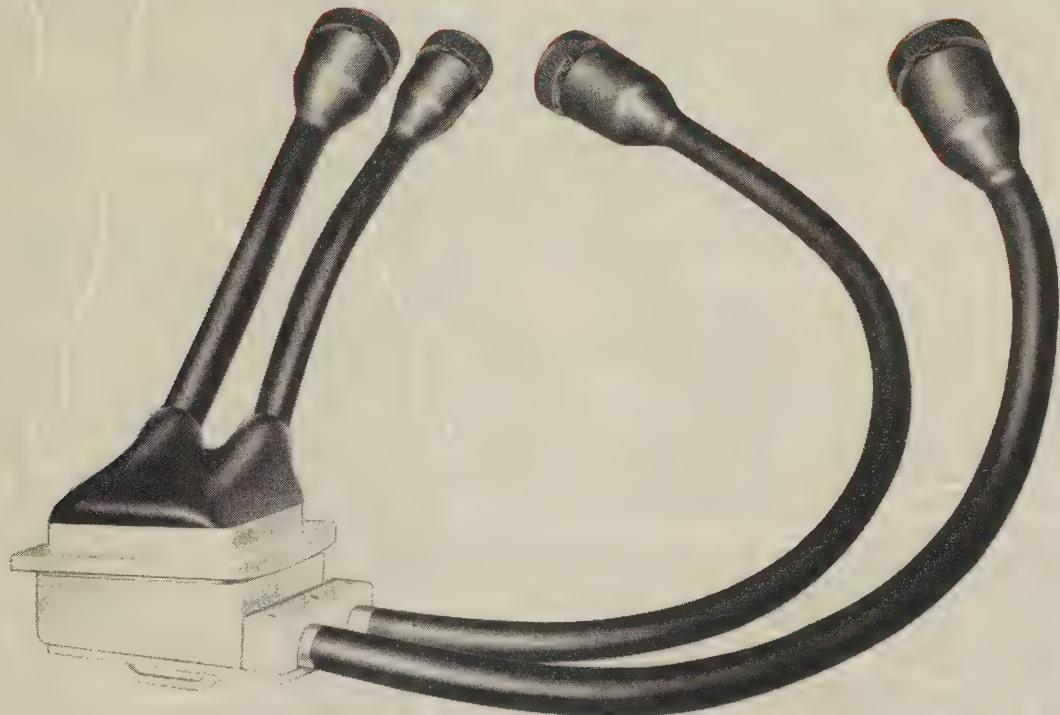
Series A units have a normal range of -65 to +250 deg F. Series AHT operate from -65 to 350 deg F; AXT, from -100 to +525 deg F. All units are accurate to within  $\pm 5$  per cent or better and have a linearity of  $\pm 1$  per cent.

Write in No. 435 on Reader Service Card  
more on page 346

*for an extension in Reliability*

*engineered...*

# CANNON PLUG/HARNESS SYSTEMS



## SINGLE RESPONSIBILITY FOR PERFORMANCE OF PLUG/HARNESS SYSTEMS...RELIABILITY GUARANTEED!

■ **CANNON PLUG/HARNESS SYSTEMS** are designed and manufactured under rigid, quality-controlled conditions in a separate, highly specialized facility completely equipped to handle all phases of design, development and manufacture. As a single source supplier for both plugs and harness assemblies, Cannon can assume complete responsibility for the reliability of the "Cannon Plug/Harness System" as a whole.

■ **COMPLETE TESTING FACILITIES:** Extensive testing equipment is also available to duplicate environmental conditions. These include vibration tests, temperature cycling tests, and heat flux tests duplicating heat re-entry conditions. Each system is 100% tested for continuity and for high potential and insulation resistance, shorts or grounds as well as humidity, VSWR, contact retention, etc. Certified test reports are available.

■ **SPECIAL DESIGN SERVICES:** Because Cannon is a single source supplier of the plugs and completes the termination, it is possible to select and recommend cables and termination techniques designed to custom-match the proper plug for the assembly. The complete assembly can thus be manufactured and tested under conditions prohibited to single-source suppliers.

■ **FASTER DELIVERY - NO COST PYRAMIDING:** A special, separate facility devoted to umbilical and harnessing production offers the most up-to-date production techniques to provide the industry's fastest delivery—plus no pyramiding of costs. Customers draw on Cannon's capabilities as the world's largest exclusive manufacturer of electrical plugs.

■ **FIELD TECHNICAL ASSISTANCE:** Experienced specialized sales engineers are available to discuss and assist customers in the technical aspects of plug-harness system requirements prior to manufacture and after installation in the field.

FOR FURTHER INFORMATION on Cannon Plug/Harness Systems write for Cannon Catalog HC-1—Cannon Electric Company, 3208 Humboldt Street, Los Angeles 31, Calif. Please refer to Department 115.

CANNON ELECTRIC COMPANY  
—Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne and Tokyo.

Distributors and Representatives in principal cities of the world.

**CANNON**  
**PLUGS**



Write in No. 230 on Reader Service Card at start of Product Preview Section



## dead center

Kelsey-Hayes thrust vectoring systems give missiles proper directional control.

Kelsey-Hayes is contributing substantially to the design, development and production of new thrust vector control systems for solid fuel propulsion.

For example Kelsey-Hayes, in a recent crash program, designed and fabricated a movable nozzle control that passed static firing tests for one of the newest sophisticated missile systems.

The swivel nozzle control is just one of the latest developments by Kelsey-Hayes as a subcontractor of propulsion subsystems, flight componentry and high performance materials. Spearheading Kelsey-Hayes activities is the Advanced Design Group, a flexible team of experienced design specialists. Kelsey-Hayes Company, Detroit 32, Michigan.

## KELSEY HAYES COMPANY

Automotive, Aviation and Agricultural Parts  
Hand Tools for Industry and Home

18 PLANTS: Detroit and Jackson, Michigan; Los Angeles; Philadelphia and McKeesport, Pennsylvania; Springfield, Ohio; New Hartford and Utica, New York; Davenport, Iowa; Windsor, Ontario, Canada.



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SPACE/AERONAUTICS

LOOK  
FOR THE  
**DIAMONDS—SIGN**  
OF FINISHING  
QUALITY

Only

**IRIDITE®**

## Process Engineered Chromate Conversion Coatings

Give you 5 additional benefits for Corrosion Protection—Paint Base—Decorative Finishing

### 1 A COMPLETE PROCESS ENGINEERED LINE

Developed for specific applications, there is an Iridite to provide the finish you desire, fit the equipment you have available and give the performance you require. Most Iridite coatings meet rigid military and civilian specifications.

### 2 EXPERIENCED TECHNICAL SERVICE

Our large field engineering staff is thoroughly familiar with chromate conversion coatings and related finishing operations. They'll help you check every step in your finishing operation to make sure you're getting the best possible finish on your products.

### 3 PRODUCT AVAILABILITY

Warehouses located in strategic industrial

areas enable us to provide you with fast, economical delivery on any Iridite.

### 4 ECONOMY

The superior performance of Iridite provides low final cost by extending operating life and lowering maintenance costs. In addition, Iridite gives you a finish that adds considerably to the value of your product. There's an Iridite to meet every cost and performance requirement.

### 5 RESEARCH AND DEVELOPMENT FACILITIES

If you have an unusual application, we will gladly work with you. Our entire staff of experienced engineers and chemists, and our completely equipped facilities are at your service.

**IRIDITE**—a specialized line of chromate conversion coatings for non-ferrous metals. Apply by dip, brush or spray methods — at room temperature — manually or with automatic equipment. Forms a thin film which becomes an integral part of the metal. Cannot chip, flake or peel. No special equipment, exhaust systems or specially trained personnel required.

If you are using chromate conversion coatings to finish zinc, cadmium, aluminum, magnesium, silver, copper, brass or bronze — consider the above benefits of Iridite. For complete information, contact your Allied Field Engineer. He's listed under "Plating Supplies" in the yellow pages. Or, write for FREE TECHNICAL DATA FILE.



**Allied Research Products, Inc.**

Chemical and Electro-  
chemical Processes, Anodes,  
Rectifiers Equipment, and Supplies for Metal Finishing

**IRIDITE®**  
Chromate  
Coatings

**IRILAC™**  
Clear  
Coatings

**ISOBRITE®**  
Plating  
Brighteners

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Chemicals &  
Supplies

**WAGNER**  
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Equipment

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BRANCH PLANT: 400 MIDLAND AVENUE • DETROIT 3, MICHIGAN

West Coast Licensee for Process Chemicals: L. H. Butcher Co.

Write in No. 231 on Reader Service Card at start of Product Preview Section

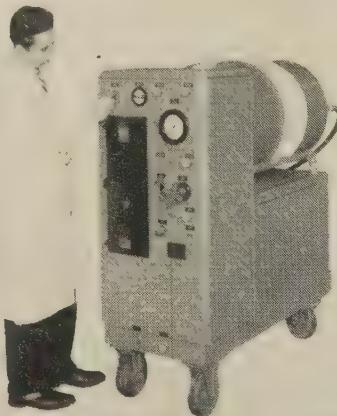
**SELF-LOCKING SCREW  
for high temperatures**

This high temperature self-locking screw is designed for supersonic applications at temperatures up to 1200 F. The self-locking screw is a patented process which includes the use of an all-metal rolled tubular insert. Torque action compresses the insert. The resiliency of the metallic tube causes a re-forming action by the insert, says Long-Lok Corp., Dept. S/A, 2601 Colorado Ave., Santa Monica, Calif. The "Hot Lok" is vibration resistant and is said to save weight by elimination of washers and safety

wire.

The screw is available in No. 2 sizes and up, minimum thread length  $\frac{1}{4}$ ", for aircraft and commercial applications.

Write in No. 436 on Reader Service Card

**CART  
filters missile oil**

A completely self-contained, portable filtration cart will filter fluids to 2-5 micron cleanliness, says George L. Nankervis Co., Dept. S/A, 15300 Fullerton Ave., Detroit 27, Mich. It is useful on missile production lines for filtering oil destined for missile hy-

draulic systems.

Fluid in the 55-gal drum it accommodates is automatically circulated in a closed loop through a network of magnetic, coarse and fine filters, until the contamination level is reduced to the rated level. An external hydraulic circuit can be simultaneously filtered if it is connected to the loop through hose fittings on the front of the stand.

Write in No. 437 on Reader Service Card

**PDM MULTICODER  
to IRIG specs**

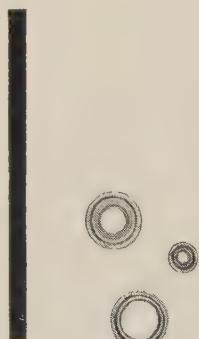
ML Series low level pulse duration modulation multicoders are available in all the standard IRIG sampling rates and channel configurations. The equipment offers high reliability under extreme environmental conditions and is extremely suited for obtaining thermocouple and strain gage in data missile flight test, says General Devices, Inc., Dept. S/A, P.O. Box 253, Princeton, N.J.

Maximum input sensitivity is 0 to 10 mv for full scale, with amplifier gain adjustable to provide any range to 100 mv for full scale. The multicoder consists of an electromechanical commutator, dc amplifier, PAM to PDM converter, and power supply.

Write in No. 438 on Reader Service Card  
**more on page 348**

**Can Tiny Bearings  
Protect  
Themselves?**

Certainly they can. Carefully armored against dirt and dust, MPB shielded bearings are ideal in applications where contamination is a problem. Also, they simplify handling and assembling by retaining lubricants. For more facts write to MPB, Inc., 1410 Precision Park, Keene, N. H.



MINIATURE PRECISION BEARINGS INC.

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**FOR LEAK-DETECTION DEVICES**

**OHIO**  
**NITROUS  
OXIDE**

EASILY  
SNIFFS OUT  
MICROSCOPIC  
LEAKS

Infrared determination of nitrous oxide provides a safe, sensitive and flexible method of leak detection. This method is not affected by usual atmosphere components such as moisture, carbon dioxide and hydrocarbons. In addition, nitrous oxide will not harm pieces being tested and is more economical than other gaseous agents.

**OHIO NITROUS OXIDE: ODORLESS AND INERT • NONTOXIC  
• NONCORROSIVE • NONFLAMMABLE • ECONOMICAL**

**FREE TECHNICAL AID** is available in the use of nitrous oxide for leak detection. For further information, please request the following bulletins:

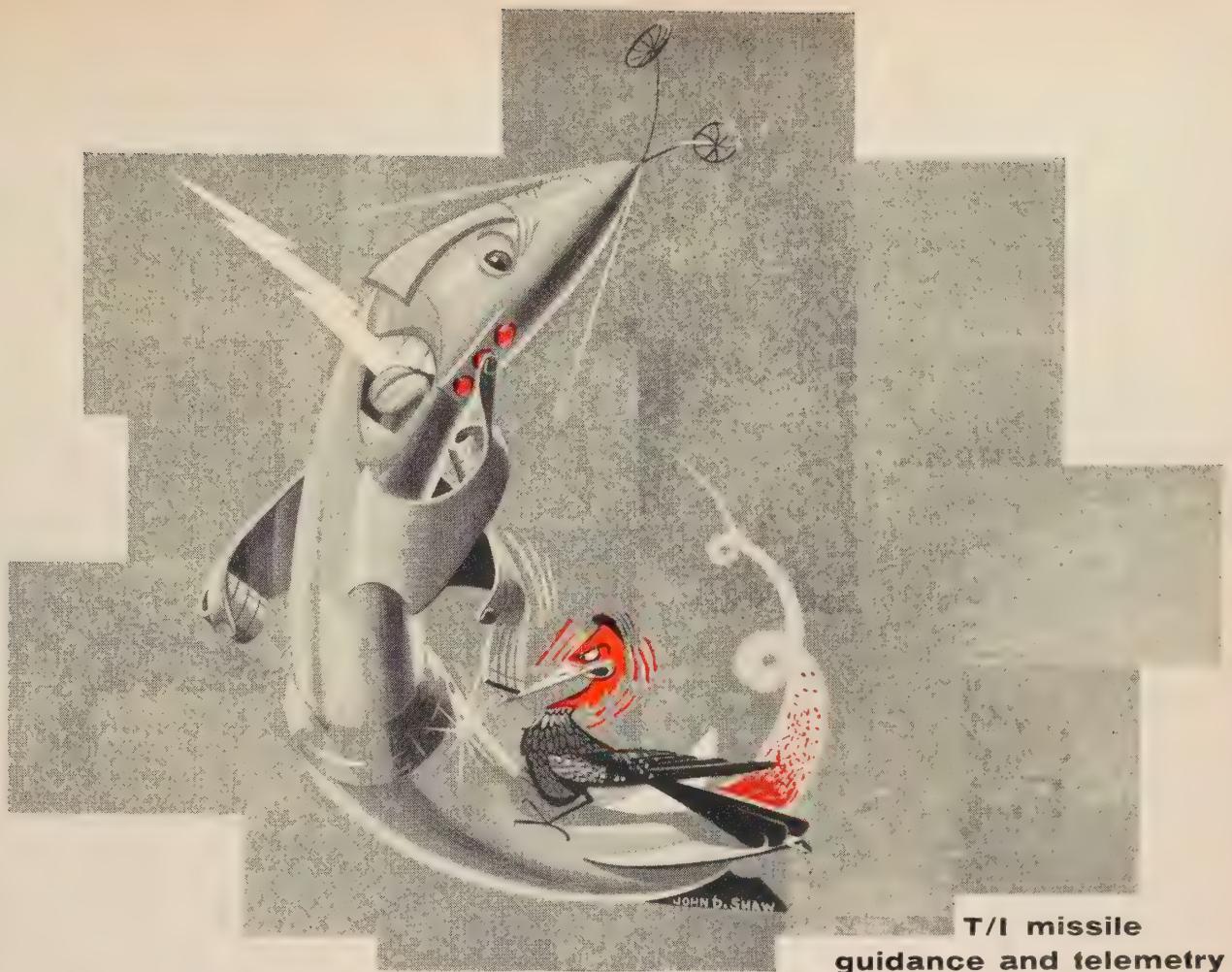
**1A** Chemical, Physical and Pharmacological Properties of Nitrous Oxide with Results of Corrosion Tests

**1B** Gas Service Equipment for Nitrous Oxide Supply

  
**Ohio Chemical**  
OHIO CHEMICAL & SURGICAL EQUIPMENT CO.  
(A Division of Air Reduction Company, Incorporated)   
MADISON 10, WISCONSIN

Write in No. 243 on Reader Service Card

SPACE/AERONAUTICS



T/I missile  
guidance and telemetry

## BEEPS WITH A HIGH IQ

...for missile sensing, guiding and telemetering

**Electronic signals** that report the truth, the whole truth, and nothing but . . . wring the best performance from missile systems. By pushing beyond known capabilities in sensitivity and accuracy, Texas Instruments is producing "high IQ" systems and equipments for a dozen guided vehicles used in every basic mission: air-to-air, air-to-surface, surface-to-air, surface-to-surface — IRBM and ICBM—plus drone sensors and satellite instrumentation. TI exceeds tough specs against tight deadlines, regularly . . . specs asking solutions to problems never posed before. For detailed discussion, cleared personnel please write or call: SERVICE ENGINEERING DEPARTMENT.

RESEARCH/DESIGN/DEVELOPMENT/MANUFACTURING of systems for: Air traffic control • Airborne early warning • Antimissile • Antisubmarine warfare • Attack control • Countermeasures • Missile systems Navigation • Reconnaissance • Space electronics; and on detector cells, engine instruments, infrared, intercom, microwave, optics, radar, sonar, telemetry, time standards, timers, transformers and other precision devices.

APPARATUS DIVISION

TEXAS

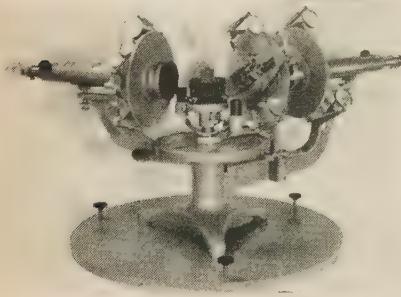


INSTRUMENTS  
INCORPORATED

6000 LEMMON AVENUE  
DALLAS 9, TEXAS

Write in No. 234 on Reader Service Card at start of Product Preview Section

# New research instrument



## Gaertner Ellipsometer

For the investigation and measurement of thin films by the use of elliptically polarized light.

An instrument of special interest to those working in the field of Solid State Physics.

These instruments are currently being utilized for the accurate measurement of extremely thin films by the methods of Drude, Rothen, Tronstad and others.

They are also adaptable to the study of birefringence, index of refraction and other characteristics and phenomena associated with thin films and surfaces, by the use of elliptically polarized light.

The basic instrument consists of a modified divided-circle spectrometer incorporating polarizing prisms and quarter wave plate mounted in vertical divided circles. A Babinet Soleil Compensator may also be used. Film under test is placed on the spectrometer table.

Gaertner Scientific Corporation, designers and manufacturers of precision optical and measuring instruments. 1270 Wrightwood Ave., Chicago 14, Ill. Telephone: BUCKingham 1-5335

Write for Bulletin 203-58

**Gaertner**  
SCIENTIFIC CORPORATION

Write in No. 235 on Reader Service Card

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## PRODUCT PREVIEW

### PRESSURE CONTROL is explosion-proof

A High Pressure Control, type H98, that is waterproof and explosion-proof control and is suitable for air, gas or liquid pressures in hazardous locations where explosive gases or vapor are present. Pressure ranges extend from 10 psi to 1700 psi, with a proof pressure of 2500 psi and a maximum pressure of 3500 psi, says United Electric Controls Co., Dept. S/A, 79 School St., Watertown 72, Mass.

It is a calibrated control. Pressure settings are made by turning a knurled knob against a calibrated dial, which may be locked with an allen wrench to avoid unauthorized tampering. A tamper proof screw-on cap also adds protection.

Write in No. 439 on Reader Service Card

### GYROS are completely floated



These completely floated rate gyroscopes capable of withstanding 150 g shock or acceleration are designed for maximum versatility and operate from either direct, or one, two or three phase alternating current. Regulated or unregulated voltage from 350 to 2500 cps can be used for the ac power supply. Extreme flexibility of unit design features a wide range of interchangeable rotors and pickoffs, says Airesearch Mfg. Div., Garrett Corp., Dept. S/A, 402 S. 36th St., Phoenix, Ariz.

The new 210 Series gyros are of completely floated gimbal construction. Damping is held nearly constant over an ambient operating range of -67 to +165 deg F. A typical gyro weighs less than a pound and measures 2-1/2 in. square by 3 in. long.

Write in No. 440 on Reader Service Card

### SILICONE RUBBER has unique qualities

This silicone rubber product called Cohrlastic FSR is a unique form, fibrous in nature, resembling sponge and foam in properties. It is a mat of fibers, oriented in a completely random manner, resulting in tensile and tear strength superior to silicone sponge and foam. The inherent permeability of the product suggests applications which cannot be met by

sponge or foam, says Connecticut Hard Rubber Co., Dept. S/A, 407 East St., New Haven, Conn.

Other properties are density in the range of 20 lbs/cu. ft; good compression-deflection characteristics; and useable temperature range of -65°F to 500°F. Presently available from pilot plant.

Write in No. 441 on Reader Service Card

### BOOM CRANE telescopes to 16 feet



Precision handling of missiles, rockets, drones, aircraft parts and other material may be accomplished by using this telescopic boom crane. It rotates a full 360 degrees within a tight radius, thereby permitting the crane, nose section of missile, base and outriggers all to be carried on a single trailer, with the missile body transported on a second trailer, says Garland Crane Co., Dept. S/A, 1100 East Hill St., Long Beach, Calif.

This Garland Super Goliath with a 60 ft. Powered at 24 V drawn from a storage battery and equipped with electric brakes in addition to manual, brakes, a light or heavy load can be raised or lowered as little as 1/16 in., it is claimed. Variable speed controls allow precision regulation of movement.

Write in No. 442 on Reader Service Card

### TRANSDUCER has wide range

This extreme-range absolute-pressure Vibrotron Transducer Model 8815, is capable of converting input pressures of zero to 1000 psi into a direct electrical output in terms of frequency. Output of the unit is in the form of an audio (FM) signal, with a frequency inversely proportional to applied pressure, says Borg-Warner Corp., Dept. S/A, 3300 Newport Blvd., Santa Ana, Calif.

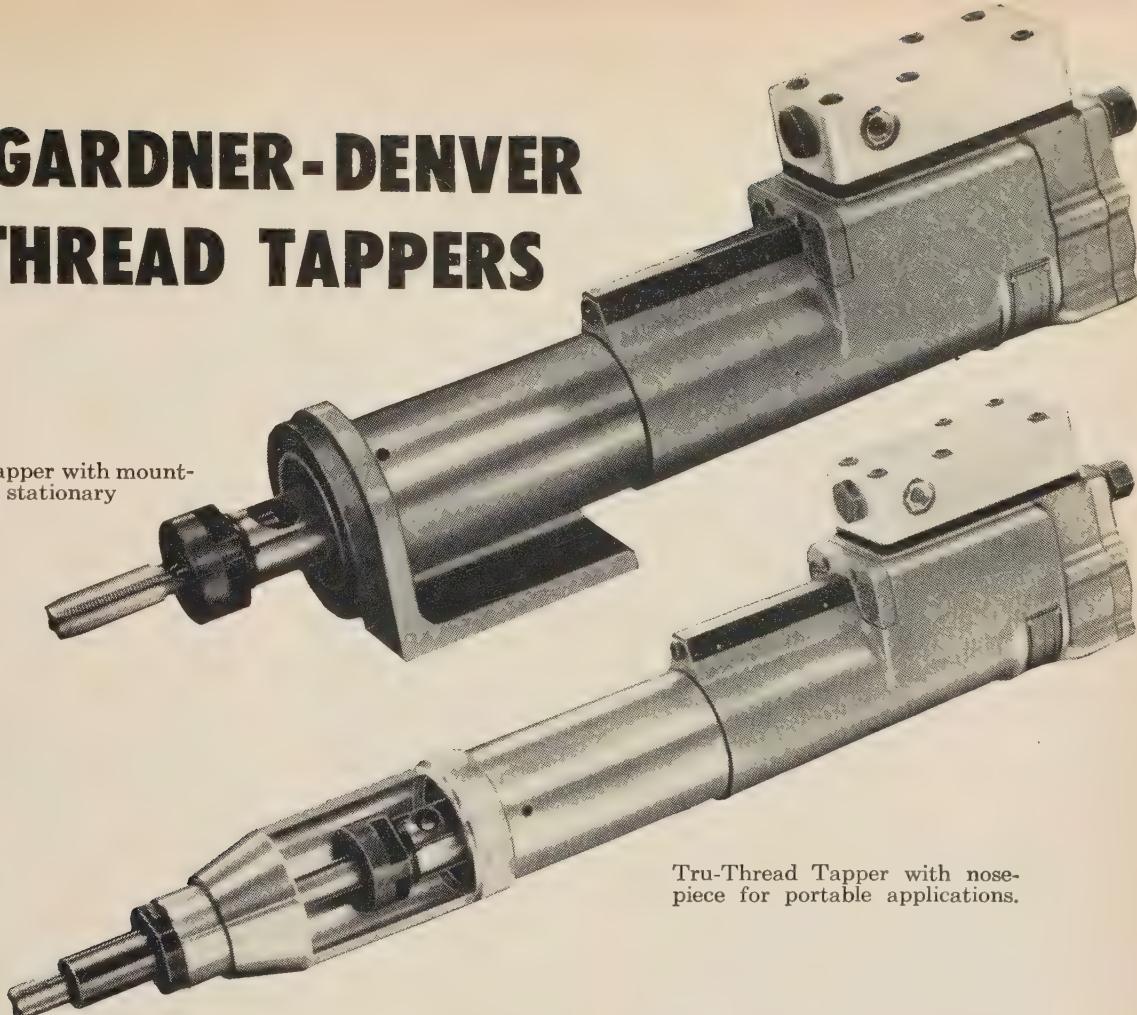
The unit is said to be readily adaptable for applications in aircraft and missiles, as well as military or industrial ground equipment, and as a component in instrumentation and systems. Sensing element portions of the instruments are hermetically sealed, and pressure media may include various types of neutral or corrosive liquids or gases.

Write in No. 443 on Reader Service Card  
**more on page 350**

SPACE/AERONAUTICS

# NEW GARDNER-DENVER TRU-THREAD TAPPERS

Tru-Thread Tapper with mounting bracket for stationary applications.



Tru-Thread Tapper with nose-piece for portable applications.

## ...CUT COSTS IN PRODUCTION TAPPING

### TIME TO TALK COST SAVING



When you keep in touch with your Gardner-Denver air tool specialist, you keep in touch with the latest developments in new methods and machines to cut production costs. This is the foundation of our 100-year philosophy of growth—at Gardner-Denver there's no substitute for men.

#### Quality performance

Now precision tapping of clean, accurate threads is quick, easy and economical with new Gardner-Denver air-powered, positive-feed Tru-Thread (T.M.) Tappers. "Controlled-pitch" lead screw feed prevents tearing or stripping of threads and tap breakage. With Gardner-Denver "controlled pitch," Model 93B Series tappers consistently produce threads of Class 3 fit quality. Single control starts completely automatic cycle.

#### Portable or stationary mounting

Mount the Tru-Thread Tapper on a simple jig or automatic machine and get low-cost, *precision* thread cutting. Keep your machine tools efficiently occupied with other work.

For portable applications, simply add a nosepiece for use with self-locking drill bushing tip. One man can easily take the tool to the work . . . from job to job.

Designed specifically for production thread cutting, the Tru-Thread Tapper is the ideal solution to all tapping problems in hole sizes from No. 2 to 1" diameter. Ask a Gardner-Denver special machines engineer how this versatile air tool can be incorporated into a fully automated unit. For complete details, request Bulletin 93-31.



EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

## GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois  
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

Write in No. 236 on Reader Service Card at start of Product Preview Section

**INVERTER****supplies sine wave power**

Model 591-J transistorized power inverter supplies ac sine wave power from battery line source. The inverter is designed for use with ac gyros and motors. There is no loss of efficiency due to sine wave operation, because the transistors are operated as saturated switching elements, says Arnold Magnetics Corp., Dept. S/A, 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

The nominal input voltage is 24, 26, or 28 V dc, output voltage is 26 and 115 V ac. Output frequency is 400 cps with 1200, 1500, and 2000 cps, available on request. Output power is 40 VA. Temperature range is from -55 to +71 deg C. Size is 2½ by 4 by 2½ in., and weight is 32 oz.

Write in No. 444 on Reader Service Card

**DEHYDRATION SYSTEM  
uses disposable cartridges**

This aviation dehydration system, model RAF-D4B, using disposable cartridges, is designed to fit many types of dehydration applications in missile and aircraft ground support pneumatic systems and any application calling for dry oil free gas, says Robbins Aviation, Inc., Dept. S/A, 2350 E. 38 St., Los Angeles 58, Calif.

Pressure range of 600 psi to 12,000 psi with flow rates as high as 550 SCFM. Minus 100° F. dewpoint and oil vapor content of less than ½ part per million by volume are obtainable with these dehydrators, it is said. Designed for use with air, nitrogen or helium. No tools required to change cartridges.

Write in No. 445 on Reader Service Card

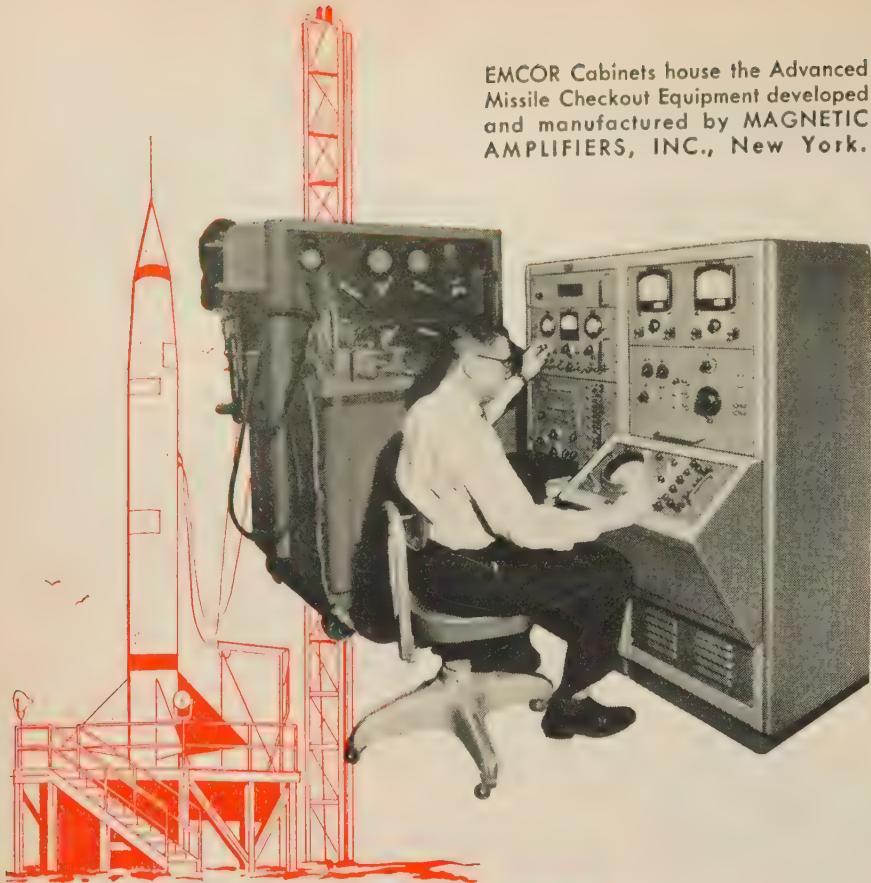
**DC AMPLIFIER  
for low level use**

This completely transistorized dc amplifier, Model EM-2000A, is a chopper amplifier not of the magnetic or mechanical chopper types. Developed for use in systems where excellent sensitivity and frequency response are required, the new unit is subminiature in its mechanical characteristics occupying 27 cu in. and weighing 12 oz, says Gulton Industries, Inc., Dept. S/A, 212 Durham Ave., Metuchen, N.J.

Among the outstanding features claimed is its higher frequency response (better than three db at 2,000 cps). Multiplexing may be done at the amplifier input, thus permitting the use of one amplifier instead of many. The high sensitivity of the amplifier permits accurate temperature measurements as low as -95 deg C with the iron constantan thermocouples, and -122 deg C with chromel-alumel thermocouples.

Write in No. 446 on Reader Service Card

**EMCOR Cabinets house the Advanced Missile Checkout Equipment developed and manufactured by MAGNETIC AMPLIFIERS, INC., New York.**



# EMCOR®

## ENCLOSURES PACKAGE ADVANCED MISSILE CHECKOUT EQUIPMENT

Besides the advanced missile checkout installation shown above, proven EMCOR Engineering "know-how" in metal cabinetry is keeping pace daily in packaging missile testing, firing and tracking equipment. Design engineers find that the flexible, versatile and structural capabilities of EMCOR Cabinets solve the increasing demands of housing the intricate electronic instrumentation required in the missile program. Costly custom cabinet design time is eliminated with over 600 basic frames to choose from in the EMCOR MODULAR ENCLOSURE SYSTEM. Put EMCOR Engineering "know-how" to work for you, write for full information today.

Your copy of catalog 106 condensed version  
available upon request



Originators of the Modular Enclosure System

**ELGIN METALFORMERS CORP.**  
630 CONGDON, DEPT. 1228 • ELGIN, ILLINOIS

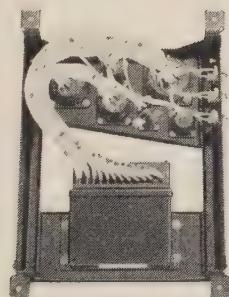
\*Registered Trademark of Elgin Metalformers Corporation

Write in No. 237 on Reader Service Card at start of Product Preview Section





## Kinetics design shrinks missile switch from 50 lb to 7 lb



As shown in this bottom view, the actual switch is much smaller than the bracket. Kinetics can put a 200-pole, double-throw switch in less than 200 cubic inches.

The original main power changeover switch in the Atlas missile that switched from ground supply to internal electrical supply just prior to launch weighed 50 lb. Now, thanks to the design ingenuity of Convair-Astronautics engineers who cut the number of circuits from 32 to 20 and to Kinetics Corporation engineers who provided a new design concept, the switch and bracket assembly weighs only 7 lb. Since a pound of savings in the missile-borne weight adds about a mile to the missile's range, this saving is truly spectacular!

The new Kinetics motor-driven switch is more rugged and reliable than previous designs and is impervious to shock and vibration. A typical Kinetics switch exhibits no contact chatter over the whole vibration spectrum, from 5 to 2000 cycles, 40 G's. The

voltage drop across typical switch contacts is less than 10 millivolts at 22 amp.

The high-density design results in many circuits per cubic inch, saving space. There are no permanent magnets or springs, no latching devices. This is truly a motor-driven switch using no elements of relays. The switch can be transferred at 40 G's, 2000 cycles. Once it's transferred, no power is required to hold it in position, saving batteries. Write or phone for more information on how this switch can be adapted to your requirements. Kinetics Corporation, Dept. K-11, 410 S. Cedros Avenue, Solana Beach, Calif. SKyline 5-1181.

**KINETICS**  
CORPORATION  
ELECTRONICS • ELECTROMECHANICS

Write in No. 238 on Reader Service Card at start of Product Preview Section



# data preview

**TAPE RECORDERS**—Five, ruggedized, miniaturized magnetic tape recorders designed for use in rockets, missiles and other airborne applications have been described in separate technical bulletins available from Borg-Warner Corp., Dept. S/A, 3300 Newport Blvd., Santa Ana, Calif. Basic types in the Northam Line include the MR-1B, an eight-track recorder.

Write in No. 447 on Reader Service Card

**VHF RECEIVER**—A six-page folder on the 51R-3 navigation-communication receiver, a 280-channel unit, has been issued by Collins Radio Co., Dept. S/A, Cedar Rapids, Ia. The crystal-controlled receiver has 100-kc spacing between 108.0 and 135.9 mc.

Write in No. 448 on Reader Service Card

**ANTENNA SYSTEMS**—A catalog, which includes price information, contains data on a number of antenna systems, towers and accessories developed and produced by All Products Co., Dept. S/A, Mineral Wells, Texas. Cable and connector data are also included.

Write in No. 449 on Reader Service Card

**ELECTRONICS**—The 1959 General Catalog, which describes aviation equipment, HF-VHF ground systems, and microwave systems, among others, has been released by Collins Radio Co., Dept. S/A, Cedar Rapids, Ia. The aviation equipment section includes information on integrated flight systems, automatic pilot, weather radar system, and airborne antennas, as well as many other devices.

Write in No. 450 on Reader Service Card

**INSTRUMENTATION**—A transistorized 150-kc frequency period meter, digital voltmeter, and a digital printer are among the 32 instruments and accessories described in a 12-page Instrumentation Catalog issued by Computer Measurements Co., Dept. S/A, 5528 Vineland Ave., North Hollywood, Calif. Time interval meters, inline-inplane readouts, and electronic go-no-go guages are also considered.

Write in No. 451 on Reader Service Card

**TRANSFORMERS**—Formulae for designing transformers for use in transistorized power supplies has been included in a four-page bulletin available from CBS-Hytron Div., Columbia Broadcasting Systems, Parker St., Newburyport, Mass. Bulletin E-285 provides a guide to transistor selection.

Write in No. 452 on Reader Service Card

**AMPLIFIERS**—A collection of data sheets on r-f and i-f amplifiers for missile, telemetry, radar and other uses has been offered in catalog form by Lel, Inc., Dept. S/A, 380 Oak St., Copiague, N.Y. Both tube and transistorized types are described.

Write in No. 453 on Reader Service Card

**COOLING SYSTEMS**—A number of cooling units for airborne electronic equipment and ground guidance systems has been described in a 4-page brochure available from Lear-Romeo Div., Dept. S/A, Abbe Rd., Elyria, O. The units may be obtained with interlocks for a preheating period during cold start and automatic controls to shut down the electronic gear when excessive fluid temperature occurs.

Write in No. 454 on Reader Service Card

**MERCURY RELAYS**—The application, operation and contact and coil ratings of mercury plunger relays have been discussed in a 12-page technical article available from Ebert Electronics Corp., Dept. S/A, Queens Village 28, N.Y. The relays' hermetically sealed, non-wearing, low resistance liquid "contacts" are designed for power loads to 7200 va ac or 1440 va dc.

Write in No. 455 on Reader Service Card

**TRANSISTORS**—Data sheets on the 2N1136, 2N1137 and 2N1138 high gain power switching transistor series have been prepared by Red Bank Div., Bendix Aviation Corp., Dept. S/A, 201 Westwood Ave., Long Branch, N.J. The sheets include use data for each of the three germanium PNP types.

Write in No. 456 on Reader Service Card

**MOTORS**—Two bulletins covering design, specifications, and applications for Model D-820, a 2 hp motor, and Model D-1000, 1.6 hp, have been issued by Hoover Electric Co., Dept. S/A, Hangar Two, Port Columbus, Airport Columbus 19, Ohio. Both models are 28 v, dc motors.

Write in No. 457 on Reader Service Card

**SWITCHES**—Eight high-temperature thermal switches and seven waterproof types have been included in a four-page catalog as typical of a line of such devices made by Control Products, Inc., S/A, 306 Sussex St., Harrison, N.J. Dimension drawings, specifications, and characteristics have been included.

Write in No. 458 on Reader Service Card

**FLIGHT CONTROL**—Fully automatic three-axis control for all high performance transport and business aircraft is possible with the AP-103 automatic flight control system, according to a six-page folder issued by Collins Radio Co., Cedar Rapids, Ia. The system provides control of all standard flight maneuvers, navigational course following with crosswind correction, yaw damping, and air speed and altitude compensation.

Write in No. 459 on Reader Service Card

**SERVO UNITS**—Technical details of servo units are given in pamphlet 107 prepared by Servo Units, Ltd., Dept. S/A, Farnborough Road, Farnborough, Hants., England. The pamphlet describes motors fed by power transistors and its system of controls for both dc and ac units.

Write in No. 460 on Reader Service Card

**DISTANCE DETECTOR**—An electro-mechanical transducer that generates an output voltage as a function of distance has been described in Bulletin 15-1 by Bently Scientific Co., Dept. S/A, 2811 Seventh St., Berkeley 10, Calif. The Model D-15 distance detector includes control unit and sensor.

Write in No. 461 on Reader Service Card

**STRAIN GAGE**—A 24-page article compares the characteristics of resistance strain gages made by eight manufacturers, prepared by Stein Engineering Services, Dept. S/A, 5601 E. Monte Rosa, Phoenix, Ariz. The publication is entitled "How to Select a Strain Gage."

Write in No. 462 on Reader Service Card

**GAS REGULATORS**—A comprehensive catalog entitled "High Pressure and Large Volume Gas Regulators," has been compiled by Missile Div., Victor Equipment Co., Dept. S/A, San Francisco 7, Calif. Sections tabbed for easy reference cover loaders, Gas-O-Dome regulators, and single- and two-stage spring-loaded regulators.

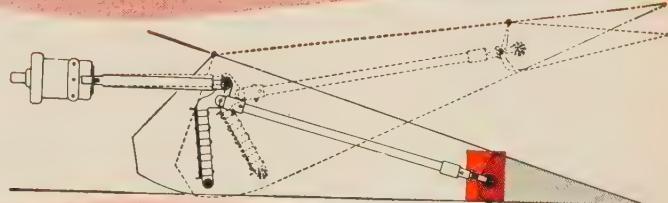
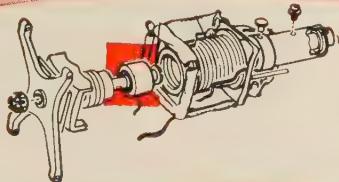
Write in No. 463 on Reader Service Card

**SPEED REDUCERS**—The new Series 8 & 9 miniature speed reducers, available in over 400 fixed ratios, have been described in Bulletin 97 by Metron Instrument Co., Dept. S/A, 432 Lincoln St., Denver 3, Colo. The units handle speeds up to 10,000 rpm and torques up to 24 oz-in., and the Series 9 types can hold backlash to less than 15 min.

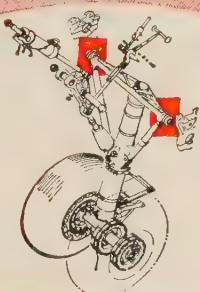
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more on page 356

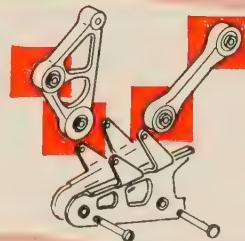
# SHAFFER® BEARINGS CARRY THE LOAD



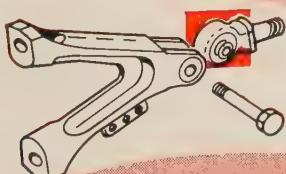
Elevator flight controls



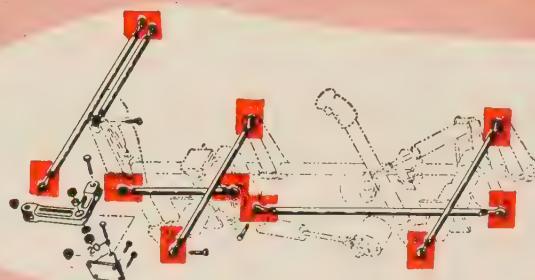
Aileron trim and servo tab control system



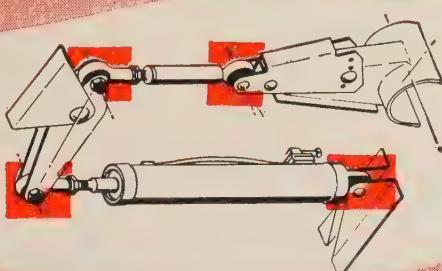
Main landing gear fulcrum and linkage



Aileron hinge

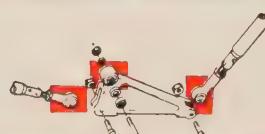


Wing flap hinge and linkage



Hydraulic actuator linkage

Helicopter flight control group



Helicopter blade pitch control link

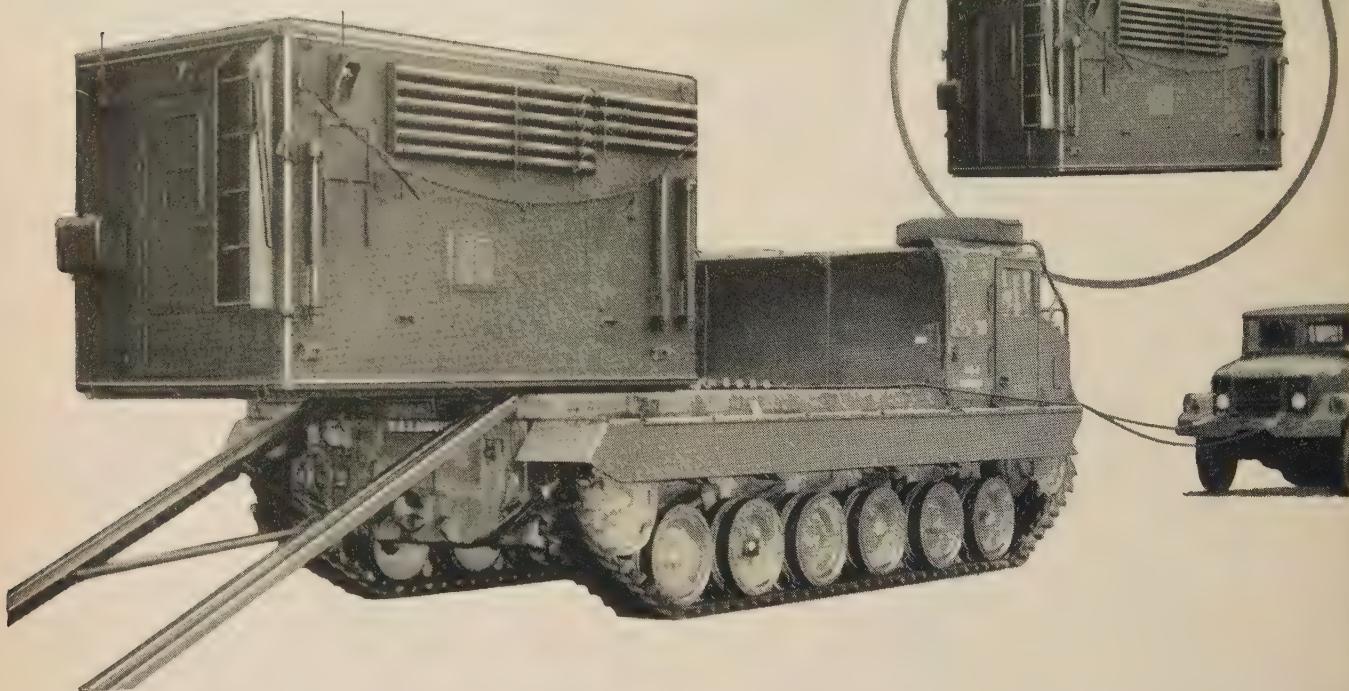
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**TRANSPORTERS**—The world's leading builder of commercial Trailers, Fruehauf has designed and constructed some 400 specific types of containers

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When confronted with a military ground handling problem, consult Fruehauf—America's most dependable, capable, experienced source of ideas and precision-produced equipment.

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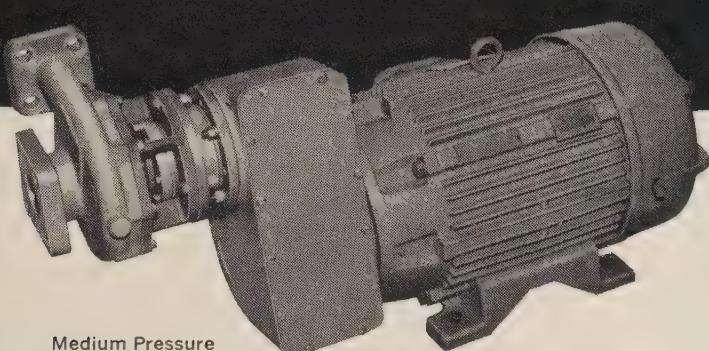
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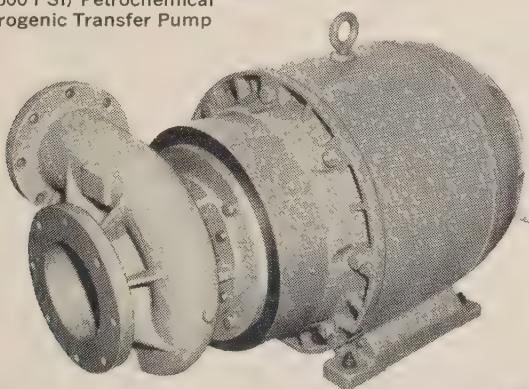
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High Flow, close-coupled Petrochemical  
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**SWITCHES** — Acceleration switches with only one moving part—a steel ball held against a solid base by a uniform magnetic field, have been described in a four-page brochure available from Inertia Switch, Inc., Dept. S/A, 311 W. 43rd St., New York 36, N.Y. The switches are sensitive to acceleration axially, radially or omnidirectionally over a 0.01 to 500-g range, and accuracy is within 0.1 per cent.

Write in No. 465 on Reader Service Card

**LAMINATIONS** — A number of magnetic laminations have been described in Bulletin TB104 by G-L Electronics, Dept. S/A, 2921 Admiral Wilson Blvd., Camden 5, N.J. The four-page folder contains data on precision-made, high-permeability transformer laminations, magnetic head laminations, and special shapes.

Write in No. 466 on Reader Service Card

**FACILITIES** — An illustrated brochure describing engineering, production, and services has been issued by the Adams-Rite Mfg. Co., Dept. S/A, 540 W. Chevy Chase Dr., Glendale 4, Calif. The publication details the machinery in place for prototype development, tooling, production and testing.

Write in No. 467 on Reader Service Card

**TUBES** — Bulletin PT-29, a four-page selection chart listing characteristics and typical performance data of unclassified General Electric microwave power tubes has been released by General Electric Co., Dept. S/A, Schenectady 5, N.Y. Traveling wave tubes, lighthouse-planar types and klystrons are among the types included.

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**SWEEP GENERATORS** — Short Form Catalog 8-A is a four-page bulletin containing extensive information on the operation, construction, and features of the sweep generators and allied equipment made by Telonic Industries, Inc., Dept. S/A, Beach Grove, Ind. All generator models are listed on a chart with their major performance specifications.

Write in No. 469 on Reader Service Card

**TRANSISTORS** — A six-page description of its PNP alloyed junction silicon transistors has been issued by General Transistor Corp., Dept. S/A, 81-27 138th Pl., Jamaica 35, N.Y. Brochure S-100 covers high and medium speed switch types, high and medium speed linear amplifier types, and high voltage types.

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**TEST SET** — Bulletin 22-5 describes a new dielectric test set, available in bench or portable versions, made by James G. Biddle Co., Dept. S/A, 1316 Arch St., Philadelphia 7, Pa. Step-voltage-current (or resistance) tests and voltage withstand and breakdown tests are possible on the insulation of electrical equipment with voltage ratings in the 300-, 600- and 2500-V classes and higher.

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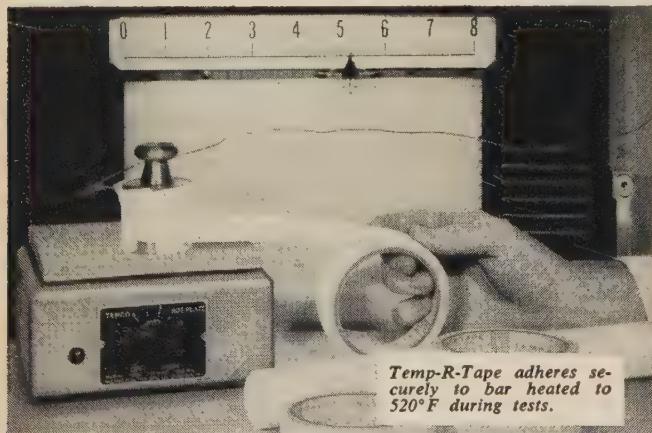
**CAPACITORS** — Superior operating stability and high capacitance for small size are among the features claimed for a line of tantalum wire electrolytic subminiature capacitors covered in Bulletin 148F by Ohmite Mfg. Co., Dept. S/A, 3673 Howard St., Skokie, Ill. The capacitors also have the ability to operate efficiently in temperature extremes.

Write in No. 472 on Reader Service Card

**BALANCER** — A machine that accommodates rotors from 2 to 600 pounds with swing diameters up to 76" is described in Bulletin SU-7 issued by Micro Balancing, Inc., Dept. S/A, Garden City Park, N.Y. It contains data and specification.

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more on page 358



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Check Employment Inquiry Form on Page 233

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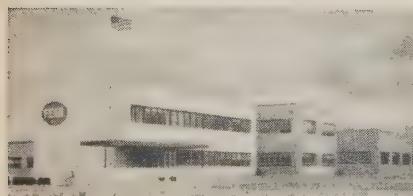
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components  
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- Write for Facilities Folder. The Fenn Manufacturing Company, Fenn Road, Newington, Connecticut.



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358

**DIGITAL OUTPUT**—The Digistep motor, a digital output device that relies on the number and rate of pulses for its angular displacement and angular velocity, respectively, has been described in Brochure W.O. 9010 by Lytle Engineering & Mfg. Co., Dept. S/A, 1404 San Mateo Blvd. S.E., Albuquerque, N.M. The unit may be used in timing, switching, programming, remote control, counting, or systems checkout.

Write in No. 474 on Reader Service Card

**SWITCH ASSEMBLIES**—A "cock-and-fire" actuating mechanism and non-tease circuitry are featured in a new series of rotary selector switch assemblies considered in Data Sheet 162 by Micro Switch Div., Minneapolis-Honeywell Regulator Co., Dept. S/A, Freeport, Ill. The 28AS assemblies are for aircraft, electronic and computer panels.

Write in No. 475 on Reader Service Card

**RECORDER**—Transistorized electronics and a unique magazine loading feature are highlights of a magnetic tape instrumentation recorder described in an eight-page brochure, Bulletin 55, available from Precision Instrument Co., Dept. S/A, 1011 Commercial St., San Carlos, Calif. The PS-200 is a seven-channel recorder-reproducer requiring 250 W and weighing 65 lbs.

Write in No. 476 on Reader Service Card

**POWER TRANSMISSION**—The Posiflex line of miniature flexible couplings and shaft joints has been described in a four-page catalog available from Fourdee, Inc., Dept. S/A, P. O. Box 6006, Orlando, Fla. Application information is included.

Write in No. 477 on Reader Service Card

**POTENTIOMETERS**—Complete details of all production model Helipot precision potentiometers, associated turns-counting dials, delay lines, trimming potentiometers and lab model pots have been included in a 20-page potentiometer catalog released by Beckman Instruments, Inc., Dept. S/A, 2500 Fullerton Rd., Fullerton, Calif. Single-turn and multi-turn units are grouped separately.

Write in No. 478 on Reader Service Card

**DATA DISPLAYS**—Design and performance details of a representative group of Servo repeater indicators; drift angle and ground speed indicator; droops, flaps and trim position indicator; CC-4 contact analog flight display; automatic navigation flight instrument; directional horizon indicator, are contained in a brochure called "Advance Data Displays" by Waldorf Electronics, Dept. S/A, Park Ave., Huntington Sta., N. Y.

Write in No. 479 on Reader Service Card

**GENERATORS**—A data sheet containing technical details on generators, including ac and dc tachometer, rate, tachometer with squirrel cage rotor, damping and dc motor generators has been issued by John Oster Mfg. Co., Avionic Div., Dept. S/A, 1 Main St., Racine, Wis.

Write in No. 480 on Reader Service Card

**TEST EQUIPMENT**—Environmental test equipment is the subject of a wallet-size chart prepared by Conrad, Inc., Dept. S/A, Conrad Sq., Holland, Mich. It shows altitude in 1,000' increments to one million eight hundred thousand feet; corresponding temperature in degrees F.; pressure in millimeters of mercury, in inches of mercury and pounds per sq. in.; vacuum equivalents, microns to millimeters of mercury, and other factors.

Write in No. 481 on Reader Service Card

**TRANSDUCER**—A technical report of tests on an absolute pressure transducer (Model 717) has been prepared by Bourns Laboratories, Inc., Dept. S/A, P. O. Box 2112, Riverside, Calif. It defines procedures, low temperature, high temperature, high temperature shock, shock, acceleration, leakage, overpressure and life tests.

Write in No. 482 on Reader Service Card

**BALL VALVES**—Venturi-flow ball valves are described in Data Sheet WF 1538 by Waldorf Fluid Systems, Dept S/A, Wolf Hill Rd., Huntington Sta., N. Y. It contains drawings, illustrations, and information on pressures and temperatures.

Write in No. 483 on Reader Service Card

**SWITCHES**—A color catalog having dimension drawings of major items and photographs of all its products, plus technical information on lighting, indication, mounting and arrangement, is the subject of Catalog 67 prepared by Minneapolis-Honeywell Regulator Co., Micro Switch Div., Dept. S/A, Freeport, Ill. It is called "Series 2 Lighted Indicator and Push-button Switch Devices." The company also has issued illustrated data sheet 156 for its "CX" series of rain-tight, explosion-proof switches.

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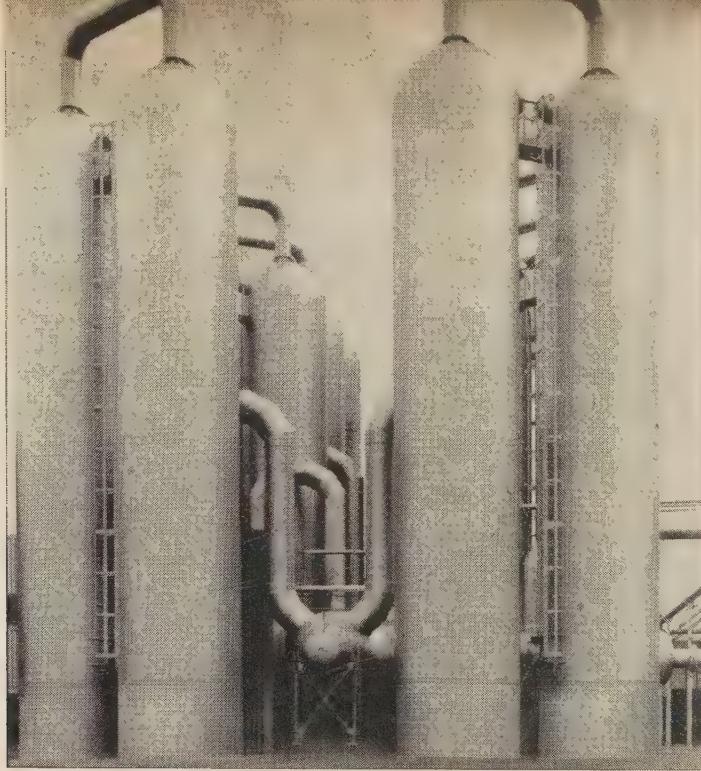
**ANTENNAS**—A comprehensive catalog containing data sheets on their parabolic antennas and accessories is available from Gabriel Co., Gabriel Electronics Div., Dept. S/A, 135 Crescent Rd., Needham Hts., Mass. Passive reflectors, commercial communication antennas, and other unclassified military antennas are also described.

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more on page 360

SPACE/AERONAUTICS

# AIR



## for supersonic wind tunnel supplied by pressure tanks built of "T-1" Steel

It takes vast quantities of high pressure air to create a supersonic wind. These 12 tanks supply air at 600 psi to a 20-inch supersonic blow-down wind tunnel at NASA's Langley Aeronautical Laboratory, Langley Field, Virginia. They were designed and built of USS "T-1" Constructional Alloy Steel by Pittsburgh-Des Moines Steel Co. Each tank is 63 feet high by 11 feet in diameter.

With total volume, pressure and available ground area specified, the problem in this design was to determine the most economical size and number of tanks to do the job. If made of standard boiler steel, the tank walls would have had to be nearly three times thicker than the  $1\frac{1}{4}$ " made possible by USS "T-1" Steel. With this three-times-stronger alloy steel, the tank heads are only  $\frac{5}{8}$ " thick, compared with a requirement of nearly 2" thick if made of lower-strength material.

These vessels are good examples of the savings possible with high yield strength USS "T-1" Steel. Much less steel was required; there were vast savings in welding, foundation and volume—and, very important because of space limitations, there was a large reduction in ground area required. The vessels were designed to a working stress of 40,000 psi and 90% joint efficiency. The tensile strength of USS "T-1" Steel for pressure vessel applications is now a full 115,000 psi.

*How USS "T-1" Steel saves.* These vessels required much less steel than normally used—so there was a sizeable reduction in freight costs. They required less material for foundations. Volume of weld metal was also drastically reduced. And they saved ground space in an area where available space was limited.

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### United States Steel

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**LAB INSTRUMENTS** — The selection and use of a wide variety of electrical measuring instruments in experimental laboratories have been covered in an eight-page publication available from Weston Instruments Div., Daystrom, Inc., Dept. S/A, 614 Frelinghuysen Ave., Newark 12, N.J. Topics discussed in Reprint Z-32 include type, range and ratings of instruments, instrument accuracy, effects of overloads, dc and ac measurements, and the taking of data.

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**FERRITES** — Descriptions of ferrite compounds suited to microwave applications in such devices as resonance isolators, Faraday rotation devices, circulators, and others operating at frequencies in the L. S. and X bands, or at intermediate frequencies above or below these bands, may be obtained from Kearfott Co., Inc., Dept. S/A, 1500 Main Ave., Clifton, N.J. Rods and bars of the compounds are available in standard size and special shapes.

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**FOCUSING ARRAYS** — Information on its activities in the design and manufacture of permanent magnet periodic focusing arrays for traveling wave tubes is available from Kearfott Co., Inc., Dept. S/A, 1500 Main Ave., Clifton, N.J. Facilities of the company's solid state physics laboratory make possible the supply of a variety of arrays useful over a wide range of ambient temperatures.

Write in No. 488 on Reader Service Card

**TEST CARTS** — Hydraulic test carts that simulate missile hydraulic power packages for production checkout have been described in Bulletin 1370, a four-page publication available from George L. Nankervis Co., Dept. S/A, 15400 Fullerton Ave., Detroit 27, Mich. The Model 9440 test carts deliver ten gpm of hydraulic oil at pressures up to 3000 psi.

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**MULTIPLIER PHOTOTUBES** — Specifications and circuit data on its current line of multiplier phototubes have been included in a 90-page catalog available from Allen B. Du Mont Laboratories, Inc., Dept. S/A, 750 Bloomfield Ave., Clifton, N.J. This second edition of the catalog includes discussions on ultraviolet and solar blind types.

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**DC AMPLIFIER** — The Model 114A differential amplifier, designed to eliminate ground loop noise problems resulting from long cable runs, has been described in a specification sheet issued by Cohu Electronics, Inc., Dept. S/A, Box 623, San Diego 12, Calif. The instrument is capable of attenuating ground loop noise by 160 db, in the case of dc, or 120 db for 60-cycle hum.

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**CONNECTORS** — A wide variety of electrical connector styles has been thoroughly described and illustrated in terms of typical applications, contact arrangements and other factors by Electrical Products Div., Joy Mfg. Co., Dept. S/A, 1241 Macklind Ave., St. Louis 10, Mo. The 12-page Catalog B73 also lists electrical current ratings for cable.

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**MAGNETIC AMPLIFIERS** — A four-page color bulletin describing series 400 CPS precision magnetic amplifiers has been issued by Acromag, Inc., Dept. S/A, 22519 Telegraph Rd., Detroit 41, Mich. Called Bulletin 401-A, it contains drawings of basic circuits and typical applications.

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more on page 362

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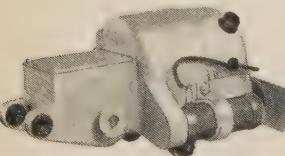


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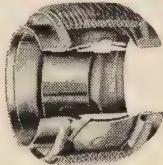
In Canada: Lamb Electric—Division of Sangamo Company Ltd.—Leaside, Ontario

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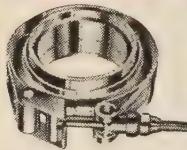
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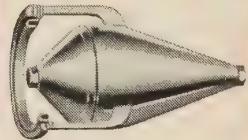
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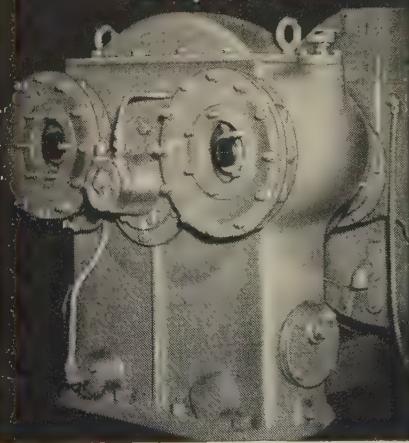
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<b>Gearing:</b>	Helical, single stage
<b>Output speed:</b>	to 30,000 RPM
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<b>Output drive:</b>	Single

All units may be supplied with stub shaft or aviation accessory drives as standard equipment.

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362

**FLIGHT SIMULATORS**—Data on compact, high response flight simulators and light-weight electric motors have been offered in separate bulletins by Task Corp., Dept. S/A, 1009 E. Vermont Ave., Anaheim, Calif. Bulletin TC-591 describes the Series 134 flight simulators for testing missile or aircraft navigational systems and components, and Bulletin TC-592 describes a new approach to electric motor design.

Write in No. 494 on Reader Service Card

**VOLTAGE STANDARD**—General specifications, technical data, outline dimensions, and diagrams for its Model 401 standard voltage unit have been issued by Jackson Electronic & Mfg. Co., Dept. S/A, 695 Johnston St., Akron 6, Ohio.

Write in No. 495 on Reader Service Card

**PRESSURE SWITCHES**—Meletron diaphragm, bourdon tube and piston pressure switches have been fully described in the 36-page Design Handbook and Catalog issued by Barksdale Valves, Dept. S/A, 5125 Alcoa Ave., Los Angeles 58, Calif. In addition to detailed information on electrical and operating characteristics, technical material includes a glossary of terms.

Write in No. 496 on Reader Service Card

**TESTING FACILITIES**—A brief survey of its extensive major environmental testing facility capabilities has been prepared by Inland Testing Laboratories, Dept. S/A, Cook Technical Center, Morton Grove, Ill. The company engages in environment qualification, production, development and procurement testing.

Write in No. 497 on Reader Service Card

**POWER SUPPLIES**—Catalog E 59 A contains data on airborne radar power supplies, dc power supplies, ac line voltage regulators, and static inverters and converters made by Perkin Engineering Corp., Dept. S/A, 345 Kansas St., El Segundo, Calif. The devices have wide application to electronic laboratories, guided missile ground checkout equipment, and aircraft ground power supplies.

Write in No. 498 on Reader Service Card

**CERAMIC FILTERS**—Low impedance, increased selectivity, greater stability, high Q, and low cost are featured in a line of miniature ceramic i-f bandpass filters described in an eight-page brochure available from Clevite Corp., Dept. S/A, 3311 Perkins Ave., Cleveland 14, O. The publication considers attenuation curves for narrow and wideband applications, insertion loss, shape factor, and impedance transformation.

Write in No. 499 on Reader Service Card

**POTENTIOMETERS**—Helinews No. 19 contains the new potentiometer line catalog of Beckman Instruments, Inc., Dept. S/A, 2500 Fullerton Rd., Fullerton, Calif. Data on three new potentiometers.

Write in No. 500 on Reader Service Card

**INDUSTRIAL SAPPHIRE**—An engineering, design and purchasing-specifications guide to industrial applications of sapphire, including jewel bearings, has been prepared by Aurele M. Gatti, Inc., Dept. S/A, 510 Tindall Ave., Trenton, N.J. The comprehensive 26-page Manual 5 discusses the use of sapphire in optical and infra-red windows, electronic control devices, wear parts, and other devices.

Write in No. 501 on Reader Service Card

**RELAYS**—A complete line of basic general purpose relays ranging from small multi-contact midgets to sensitive, heavy duty, medium power types is the subject of a 16-page catalog by Guardian Electric Mfg. Co., Dept. S/A, 1621 W. Walnut St., Chicago 12, Ill. Each relay has detailed dimensional drawings, available contact arrangements, current and coil operating data, operating speeds, terminals, weights, enclosures, terminal headers and mounting information.

Write in No. 502 on Reader Service Card

**UNIVERSAL JOINTS**—Single and double universal joints, with prices and specifications is the subject of a catalog by Curtis Universal Joint Co., Inc., Dept. S/A, Birnie Ave., Springfield 7, Mass. It contains instructions for disassembly, reassembly and lubrication key seats, setscrews and broaches available; hints for selecting the proper Curtis universal joint for any job.

Write in No. 503 on Reader Service Card

**FLOW METER**—Information on a new line of turbine flow meters for measuring the flow of jet fuel, gasoline, oil and other liquids has been provided in a four-page technical bulletin available from Cox Instrument Div., George L. Nankervis Co., Dept. S/A, 15300 Fullerton Ave., Detroit 27, Mich. Bulletin 1384 illustrates the Type 20 flow meter.

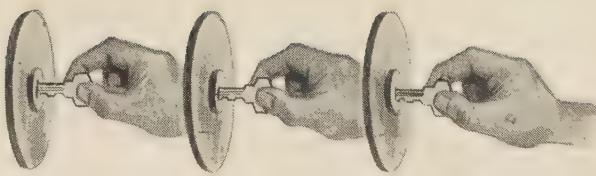
Write in No. 504 on Reader Service Card

**ACTUATORS**—Technical descriptions for electric actuators, 28 v and 400 cycle motors, screwjacks, gear boxes and control equipment are contained in Bulletin 1300 issued by Hoover Electric Co., Dept. S/A, 2100, S. Stoner Ave., Los Angeles 25, Calif. General design and operating parameters are included.

Write in No. 505 on Reader Service Card

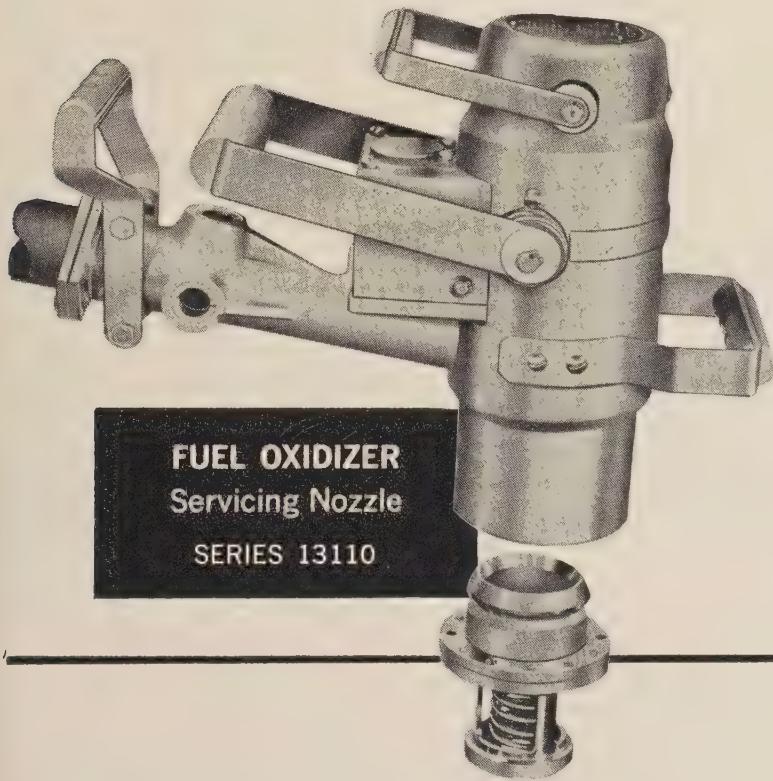
more on page 364

# 3-way locking action



*assures*

# fail-safe missile fueling



G.S.E. personnel deserve it and now can have it!... triple protection in handling oxidizers or exotic fuels... with the new Lear Fuel Oxidizer Servicing Nozzle. Fail-safe procedure requires 3 separate locking actions before fuel can flow.

Developed originally for safe transfer of nitric acid, the nozzle and adapter make possible a sealed, pressure-proofed, closed circuit servicing system to provide "safety-assured" protection. Complies with military test specifications.

## **ENGINEERING DATA...**

Flow and pressure rating . . . 125 gpm at 60 psig  
Operating temperature range . . . -65 to +140°F  
Maximum operating pressure . . . 240 psig  
Military Specifications (Test)  
Nozzle . . . MIL-N-25556 Adapter . . . MIL-N-25555

*Complete technical data and costs on request.*

RO-25

# LEAR

## LEAR-ROMEC DIVISION

ABBE ROAD, ELYRIA, OHIO

Write in No. 250 on Reader Service Card at start of Product Preview Section

**NEW!**

# BEATTIE-COLEMAN PROGRAMMER

...provides

4 2  
11 2  
8 4  
4 4  
**HOUR  
PROGRAM**  
on 13 channels

160 feet of punched Mylar tape is accommodated in the new Beattie-Coleman MLPR-13 Programer, providing a completely random program of minutes duration on 13 channels. Extremely accurate time control with no cumulative error. Available in five speeds:  $\frac{3}{16}$ ",  $\frac{3}{8}$ ",  $\frac{3}{4}$ ",  $1\frac{1}{2}$ ", and  $3"$  per sec. Weighs less than 5 lbs., is easily removable for loading. Programs can be initiated or altered in a few minutes. Compatible with most missile guidance systems.

Write for complete data on the MLPR-13 and other multi-channel Beattie-Coleman Programers for either repeat cycling or random operation.

**B** BEATTIE-  
**C** COLEMAN inc.

1000 N. Olive St., Anaheim, California  
Branch: 437 Fifth Ave., New York, N. Y.  
Write in No. 251 on Reader Service Card

**ENVIRONMENTAL TESTING**—Various temperature-vibration and temperature-altitude-vibration testing chambers have been discussed in an eight-page brochure prepared by Conrad, Inc., Dept. S/A, 141 Jefferson St., Holland, Mich. Among the chambers described is one for testing aircraft and electronic equipment under conditions simulating an altitude between 100,000 and 200,000 ft.

Write in No. 506 on Reader Service Card

**TAPE DROPOUTS**—“Reduction of Dropout Errors in Magnetic Recording Systems,” Bulletin 37 of its Sound-Talk series, has been released by Minnesota Mining & Mfg. Co., Dept. S/A, 900 Bush Ave., St. Paul 6, Minn. The four-page publication contains photomicrographs showing common types of coated-in tape flaws.

Write in No. 507 on Reader Service Card

**ACCELEROMETERS**—A data sheet on a single-axis, non-pendulous accelerometer that utilizes a spring mass system sensitive to linear acceleration along an input axis, but insensitive to those normal to that axis, has been issued by Kearfott Co., Inc., Dept. S/A, 1500 Main Ave., Clifton, N.J. The pancake-type instruments are said to be ideal for inertial guidance platforms in missiles.

Write in No. 508 on Reader Service Card

**AMPLIFIERS**—An illustrated brochure in color entitled “High Power Transistor Magnetic Servo Amplifiers” has been published by Magnetic Amplifiers, Inc., Dept. S/A, New York 55, N. Y. It contains diagrams, charts, technical data about 1 to 4 stage systems and detailed engineering and performance specifications for each system.

Write in No. 509 on Reader Service Card

**RECEIVER**—Information on the EK 07, a high-stability, ruggedized communications receiver is contained in Data Sheet N 140 E, a six-page bulletin available from Rohde & Schwarz Sales Co. (U.S.A.), Inc., Dept. S/A, Box 275, Passaic, N.J. Application described include receiving and monitoring in mobile and fixed radio stations.

Write in No. 510 on Reader Service Card

**ROTARY TABLE**—Data Sheet SL-11, a circular on a standard 24-in. tilting rotary table for the calibration and testing of navigational gyroscopes, such as those used in missile and rocket development, has been issued by Pratt & Whitney Co., Inc., Dept. S/A, Charter Oak Blvd., West Hartford 1, Conn. The design permits attachment of a adjustable frequency source to provide any speed from 7.5 to 25,200 deg per sidereal hour.

Write in No. 511 on Reader Service Card

**COIL CLUTCHES**—Catalogue and data sheets describing electro-magnetic clutches, brakes, and flexible couplings, with design specifications and suggested applications, has been prepared by Dial Products Co., Dept. S/A, P. O. Box 456, Bayonne, N. J.

Write in No. 512 on Reader Service Card

**DIRECTION DETECTOR**—Details of the Type RL airstream direction detector for measuring and transmitting local angle of airflow data have been presented in a four-page brochure by Specialties, Inc., Dept. S/A, Skunks Misery Rd., Syosset, N.Y. Bulletin ADD-RL discusses principle of operation, application, and installation.

Write in No. 513 on Reader Service Card

**RECTIFIERS**—A comprehensive, eight-page catalog that contains basic characteristics and other data on its selenium rectifiers has been published by Rectico, Inc., Dept. S/A, 963 Frelinghuysen Ave., Newark 12, N.J. Several valuable charts and tables are included.

Write in No. 514 on Reader Service Card

**INERTIAL NAVIGATION**—A 16-page booklet that outlines, in layman terms, the basic aspects of internal guidance has been prepared by Sperry Gyroscope Co., Dept. S/A, Great Neck, N.Y. “What is Inertial Guidance?” covers advantages, major components and application.

Write in No. 515 on Reader Service Card

**SEMICONDUCTORS**—“Silicon Diodes and Transistors” is a booklet listing the silicon diode and transistor families made by Sperry Semiconductor Div., Sperry Rand Corp., South Norwalk, Conn. Also included is an informative section on construction, characteristics, testing, and application.

Write in No. 516 on Reader Service Card

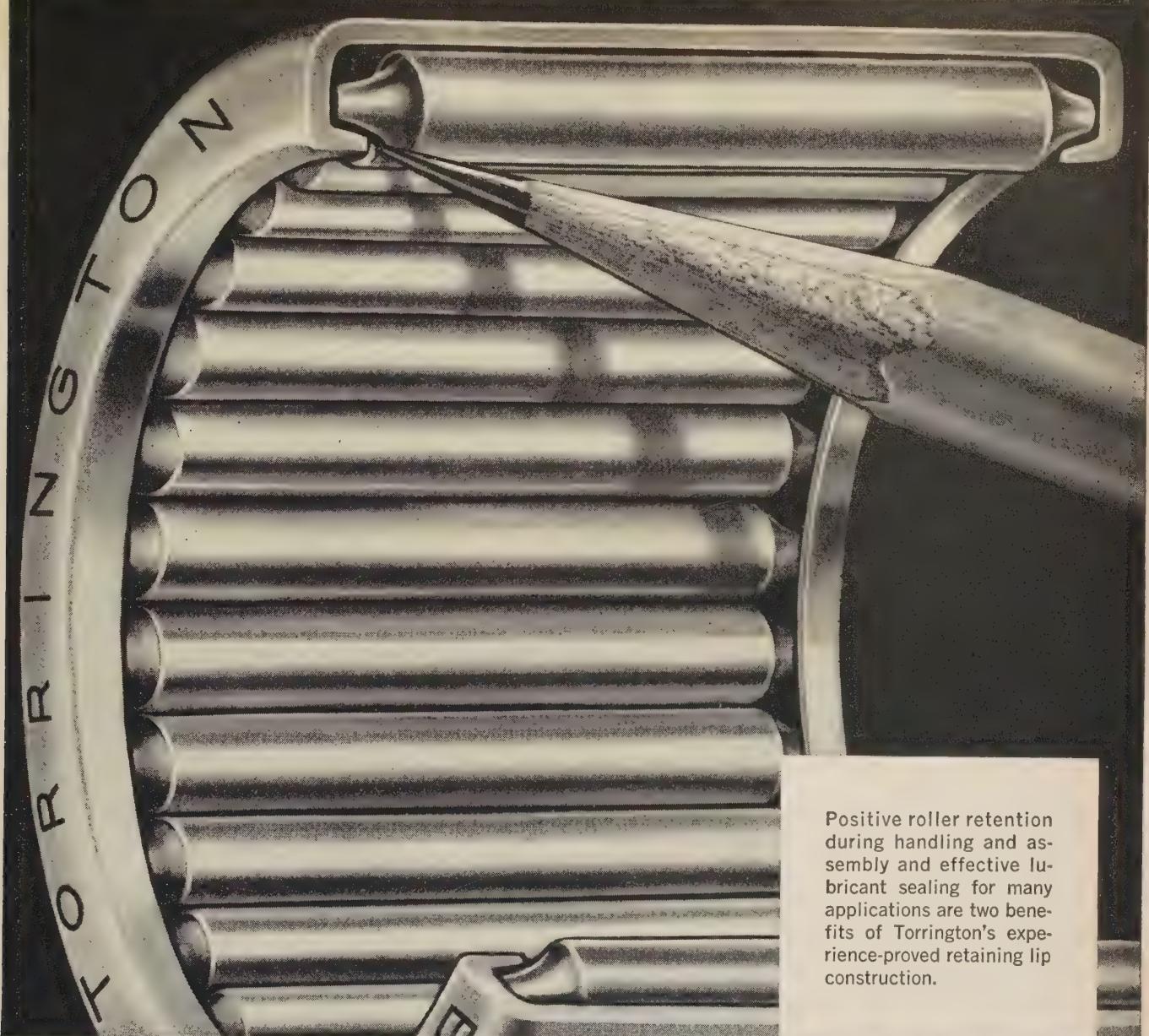
**INERTIAL GUIDANCE**—An eight-page brochure covering its complete line of inertial guidance components and equipment has been released by Sterling Precision Corp., Dept. S/A, 17 Matinecock Ave., Port Washington, N.Y. The brochure also lists engineering reports.

Write in No. 517 on Reader Service Card

**CONTAINERS**—A four-page folder describing types of fiberglass shipping and storage containers has been issued by Marco Containers, Dept. S/A, 258 Cannery St., Terminal Island, Calif. The folder is said to be especially useful for project engineers involved in packaging critical material.

Write in No. 518 on Reader Service Card

more on page 368



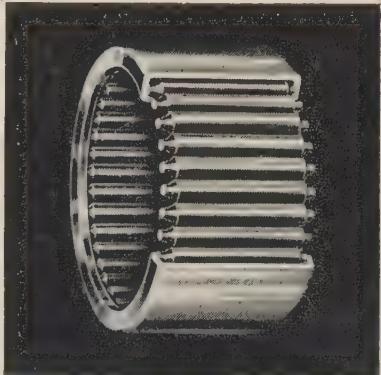
## This little lip makes a big difference!

The turned-in lip at each end of Torrington Needle Bearings positively retains the trunnion-end rollers and makes the bearing truly a complete unit, with no possibility of roller fall-out.

This unit construction simplifies installation and servicing. The closely controlled clearance and the large area between cup lips and shaft form an effective labyrinth seal. Also this retaining lip allows pregreasing the bearing with the proper lubricant for each application.

Long experience with the Torrington Needle Bearing in thousands of applications has proved the merit of this and other features in efficient performance and long service life. Make sure your product benefits from the best that experience has to offer—specify Torrington Needle Bearings. **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

Positive roller retention during handling and assembly and effective lubricant sealing for many applications are two benefits of Torrington's experience-proved retaining lip construction.



### **TORRINGTON BEARINGS**

*District Offices and Distributors in Principal Cities of United States and Canada*

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Write in No. 246 on Reader Service Card at start of Product Preview Section

# DRI PUMPS LIQUEFIED GASES AT HIGH PRESSURES AND FLOWS

20,000 SCFH AT 12,000 PSIG!

Highly approved for ground support is this DRI trailer mounted gas recharger. It is designed to convert 20,000 SCFH of LOX or LN<sub>2</sub> at 12,000 psig. Weatherproof unit is complete with high-pressure pump, vaporizer, motor driver and all controls for simple, automatic, fail-safe operation.

Dependable DRI has accumulated more than 200,000 hours successful operation of its equipment.

Write for new literature  
on all units.

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LOS ANGELES



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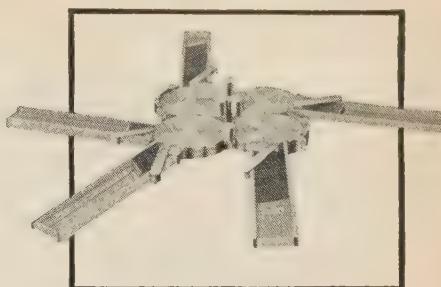
LARGE CAPACITY FILES / RAPID RANDOM ACCESS / EFFICIENT ROUTINE PROCESSING

A system with *complete* files, *complete* data and *complete* processing . . . to handle all operations.

It's a proven fact . . . that of the total work necessary to put a missile into the air, a staggering 90% is primarily logistical and involves the control of many individual maintenance parts. This figure becomes compounded as the number of inactive, but ready-to-fire missiles increases . . . and keeping track of their individual needs becomes a herculean task.

It is clear that an efficient system of organizing, filing and searching great masses of data at high speeds, and at realistic costs is necessary. *The Magnavox Company* answers the need for "discrete" unit data record handling for both government and industry with *Magnacard*.

*You are invited to investigate and make use of these new techniques . . . write today for illustrated brochure.*



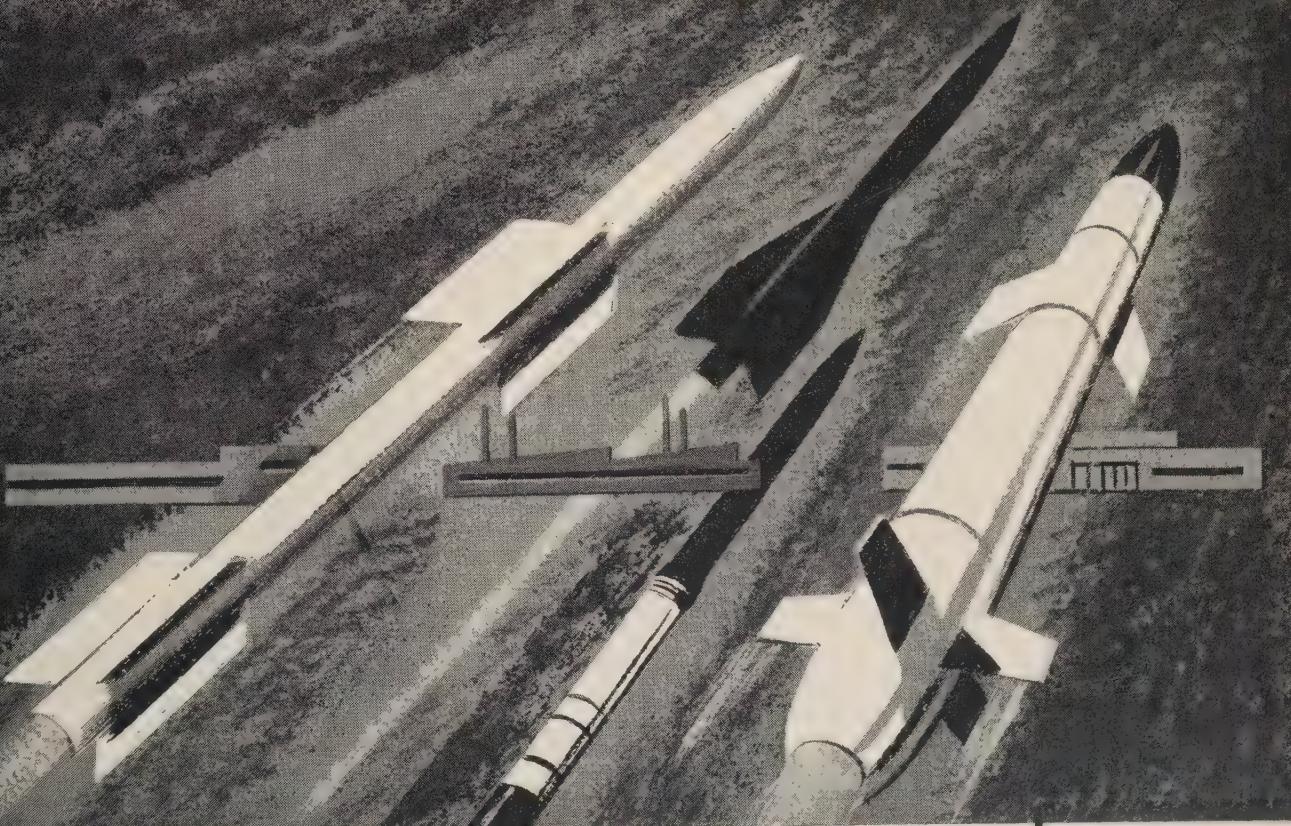
## Magnacard



DATA HANDLING EQUIPMENT BY

# Magnavox

FOR MILITARY LOGISTICS AND INDUSTRY



COMMUNICATIONS



RADAR



DATA HANDLING



ASW



MISSILES

THE MAGNAVOX CO. • DEPT. 114 • Government and Industrial Division • FORT WAYNE, IND.  
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# Lovejoy

## Flexible Couplings



**from .003 to 4250 H.P.  
1/8 in. to over 9½ in. Bores**

- Can be installed in minutes
- Align with a straight edge—no gauges required

The most trouble-free couplings you can install on your equipment... no complicated mechanisms, all parts open for inspection, reversible cushions, no lubrication required. Immediate delivery from stock in any quantity.

Send us your requirements for quick recommendations and prices. Ask about our helpful Flexible Coupling Guide Sheet and request Catalog C-56.

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### DATA PREVIEW

**TAPE PROGRAMMING**—Major details of a tape control system for automatic machine programming have been discussed in the 12-page Bulletin 176, available from Potter & Johnson Co., Dept. S/A, West Hartford, Conn. The low cost system is reported able to reduce setup and machining time by 25 per cent.

Write in No. 519 on Reader Service Card

**WIRES & CABLES**—An eight-page bulletin outlining its wire, cable and electronic products has been prepared by Sequoia Wire & Cable Co., Dept. S/A, 2201 Bay Rd., Redwood City, Calif. Missile ground test equipment, airborne missile guidance components, aircraft wire, and coaxial cable are among the products listed.

Write in No. 520 on Reader Service Card

**POWER SUPPLIES**—A four-page brochure describing a new line of compact, high voltage power supplies intended specifically for such applications as cathode ray oscilloscopes, electrostatic precipitation equipment, electron optical devices, and radar displays has been released by Del Electronics Corp., Dept. S/A, 521 Homestead Ave., Mount Vernon, N.Y. The power supplies range from 2.5 to 30 kv at 1.25 ma.

Write in No. 521 on Reader Service Card

**POTENTIOMETERS**—Specifications, diagrams and general information on a complete line of single-turn, precision wire-wound potentiometers have been included in POT 359, a 28-page technical catalog available from DeJur-Amseco Corp., Dept. S/A, 45-01 Northern Blvd., Long Island City 1, N.Y. Types range from ½-in. dia micro-miniature units to five-in. dia high-resolution models.

Write in No. 522 on Reader Service Card

**ELECTRONIC PRODUCTS**—Catalog AV-100 is a 40-page publication describing the complete facilities and products of the Avionics Div., Electronic Specialty Co., Dept. S/A, 5121 San Fernando Rd., Los Angeles 39, Calif. The catalog lists products such as static time delays, missile fuzes and programmers, voltage and frequency censors, and inverters.

Write in No. 523 on Reader Service Card

**HEAT EXCHANGER**—The space and weight saving advantages of Inner-Fin coils adapting cooling equipment to the confined systems of electronic equipment, missiles and aircraft are described in Form 5003 by Dunham-Bush, Inc., Dept. S/A, West Hartford 10, Conn. Liquid-to-air and air-to-air applications of the exchangers are described.

Write in No. 524 on Reader Service Card

**CONNECTORS**—It electrical connector facilities and techniques that have led to developments such as the miniature quick-disconnect line and snap-in connectors have been briefly described in eight-page Brochure DE-28 by The Deutsch Co., Dept. S/A, 700 Avalon Blvd., Los Angeles, Calif. The connectors are used in high-speed aircraft and missiles.

Write in No. 525 on Reader Service Card

**INSTRUMENTS**—An eight-page brochure summarizing data on a complete line of linear motion potentiometers, pressure transducers, accelerometers, and angular position transducers, has been issued by Bourns Laboratories, Inc., Dept. S/A, P.O. Box 2112, Riverside, Calif. Typical applications, construction features, operating principles, and specifications are included.

Write in No. 526 on Reader Service Card

**MICROWAVE INSTRUMENTS**—A 16-page brochure describing their line of microwave instruments is available from Radar Design Corp., Dept. S/A, Pickard Drive, Syracuse 11, N.Y. The company can supply special components and materials as well as standard microwave equipment.

Write in No. 527 on Reader Service Card

**DELAY LINES**—Data sheets on 30 Mcs to 10,000 Mcs delay lines are available from Control Electronics Co., Inc., Dept. S/A, 10 Stepar Pl., Huntington Station, L.I., N.Y. The data sheets list 4 specific high-frequency delay lines, one variable and three fixed. Impedance ranges are from 50 to 120 Ohms.

Write in No. 528 on Reader Service Card

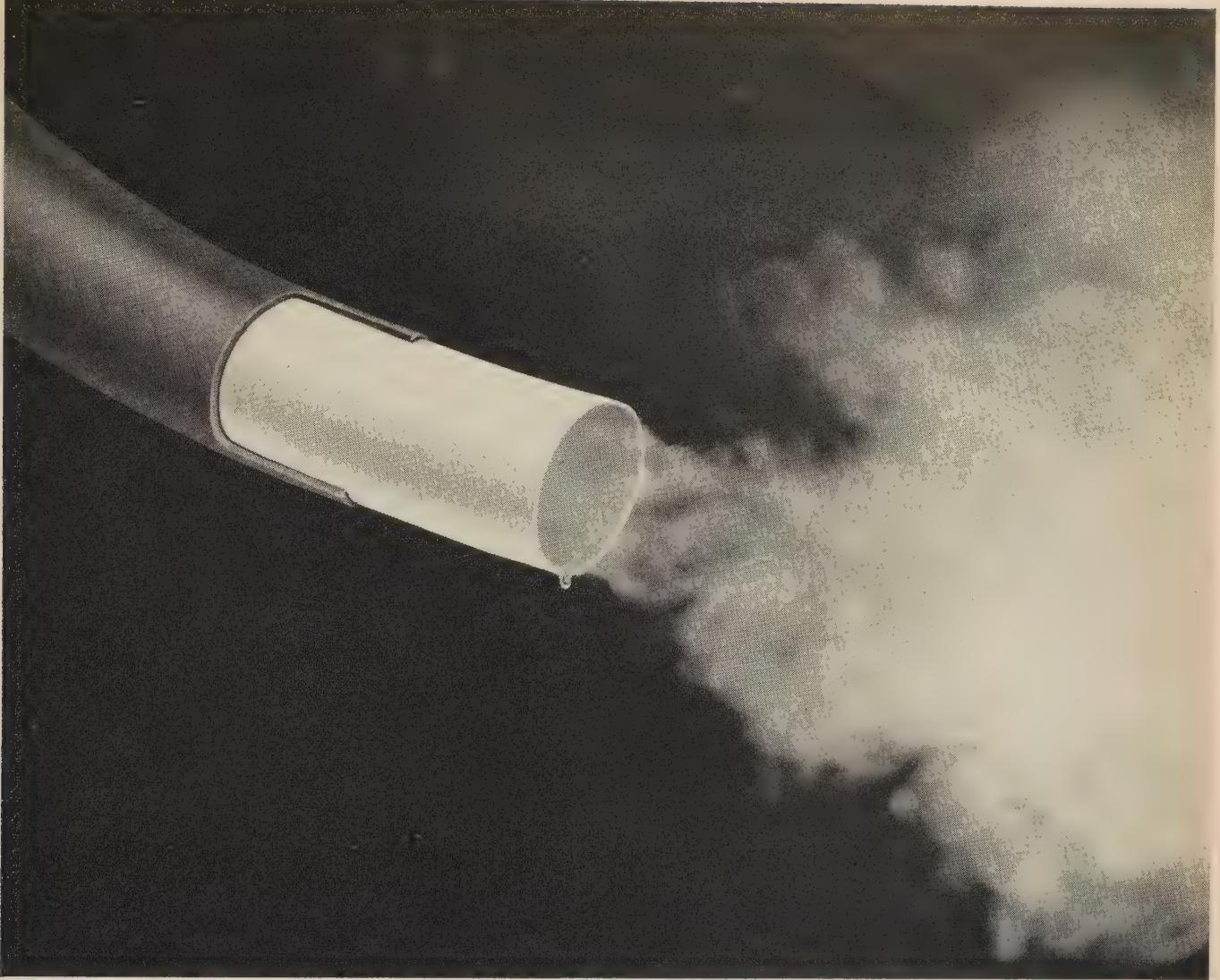
**SNAP-IN CONNECTOR**—Snap-in contacts and crimp-type terminations are featured in a solderless, miniature electrical connector briefly described in Brochure DE-19, available from The Deutsch Co., Dept. S/A, 7000 Avalon Blvd., Los Angeles 3, Calif. The DS Series connector has high resistance to temperature extremes.

Write in No. 529 on Reader Service Card

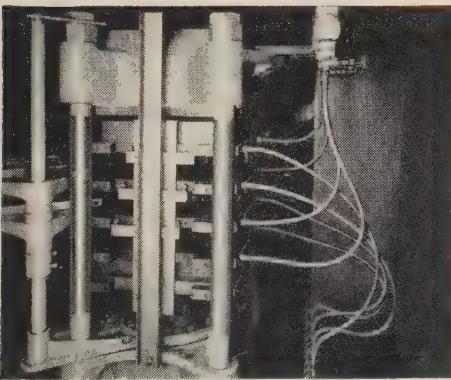
**LIMIT SWITCH**—Bulletin M-1, issued to provide engineering data on the Loxswitch Model M precision limit switch, a unit capable of surpassing 55 million cycles under electrical load, is available from R. B. Denison Mfg. Co., Dept. S/A, 102 St. Clair Ave. N.W. Cleveland 13, O. The four-page brochure points out that the rugged switch is said to be the first small machine tool switch to use a full, heavy duty latch mechanism.

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more on page 370



## Meet your needs for **HEAT RESISTANCE** with **hose of Du Pont TFE resins**



Connections on this platen press carry 350°F. steam and condensate, alternating with 45°F. water. Hoses lined with TEFLO have withstood this service continuously since May, 1955, with no signs of cracking or wear. The anti-stick properties of the TFE resin markedly reduced plugging from scale formation.

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

Hose lined with TEFLO TFE-fluorocarbon resins easily meets the requirement of high-heat resistance, imposed on hose lines by modern flight equipment. TFE resins are rated for continuous use up to 500°F. With overbraiding, hydraulic line pressures up to 6,000 psi are being achieved. In addition, the toughness of TFE resins permits the construction of lighter-weight hose for equivalent pressure ratings resulting in valuable weight savings.

Vitally important, too, is the almost universal chemical inertness of TFE resins. They are completely unaffected by all fuels, oils and hydraulic fluids. TEFLO resins also withstand conditions of continuous flexing, impulsing, and vibration.

No other materials offer this remarkable combination of properties. That's why hose of TEFLO is now standard equipment for hydraulic and fuel lines in many of the most advanced aircraft.

Find out more about how hose lined with TEFLO can meet your requirements for maximum safety and reliability with minimum weight and maintenance. Write to your supplier or: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room T-610, Du Pont Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

**DU PONT** **TEFLON®**  
REG. U. S. PAT. OFF.  
T.F.E.-FLUOROCARBON RESINS  
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Write in No. 259 on Reader Service Card at start of Product Preview Section

**TEST CHAMBERS**—Catalog 59 covers the outstanding features and specifications of the units in a line of environment test chambers made by American Research Corp., Dept. S/A, Farmington, Conn. Information on walk-in-type chambers for altitude, temperature and humidity testing is also included in the 12-page catalog.

Write in No. 531 on Reader Service Card

**LEAD WIRE**—Specifications, properties and applications for Teflon Flexlead, a high-temperature lead wire with superior electrical characteristics, have been presented in a four-page brochure by L. Frank Marke & Sons, Dept. S/A, Norristown, Pa. The flexible wire is suitable for radar, missile, guidance system, computer, relay and other applications.

Write in No. 532 on Reader Service Card

**TRANSFORMERS**—A new 32-page Catalog, CT8-58, of its transformers, carries a detailed listing of over 450 stock transformers now available. This catalog, by Chicago Standard Transformer Corp., Dept. S/A, 3501 W. Addison St., Chicago 18, Ill., gives detailed electrical and physical specifications, and shows performance curves for many of its units.

Write in No. 533 on Reader Service Card

**NUCLEAR ENGINEERING**—A new 12-page brochure, covers the activities and services of Stearns-Roger Mfg. Co., Dept. S/A, 660 Bannock St., P.O. Box 5370, Denver 17, Col., in specialized fields of ground support facilities for missiles, cryogenic engineering and handling equipment, and nuclear engineering and manufacturing.

Write in No. 534 on Reader Service Card

**GALVANOMETER**—Theory, application and specifications of the Type 7-370 computing galvanometer are considered in a four-page brochure available from Consolidated Electrodynamics Corp., Dept. S/A, 360 Sierra Madre Villa, Pasadena, Calif. Bulletin 1605A points out that the device performs the three basic functions of addition, multiplication, and subtraction, and permits calculation of power factor, average power and other multi-variable problems from a single moving trace.

Write in No. 535 on Reader Service Card

**PRECISION BOLTS**—A four-page brochure describing standard, custom-precision-made, and super alloy fasteners is available from Aircraft Bolt Corp., 701 West Garvey Blvd., El Monte, Calif.

Write in No. 536 on Reader Service Card

**SYNCHROS**—A color brochure describing synchros and rotary components, containing charts, design specifications, and technical data has been prepared by Clifton Precision Products Co., Inc., Dept. S/A, Clifton Heights, Pa. It includes linear transformers, servo motors and motor generators, dc motors, computing resolvers, etc.

Write in No. 537 on Reader Service Card

**DATA RECORDER**—Self-contained power supplies and 14-track data recording are among the features of the Type 5-701 magnetic tape recorder described in Bulletin 1578A, a four-page publication available from Consolidated Electrodynamics Corp., Dept. S/A, 360 Sierra Madre Villa, Pasadena, Calif. The recorder is recommended for data acquisition systems.

Write in No. 538 on Reader Service Card

**SERVO MOTORS**—A new bulletin, 385A, prepared for design engineers by United Aircraft Corp., Dept. S/A, Commack, Long Island, N.Y., contains applications for standard and custom servo motors including schematics of servo motors operating direct plate to plate. Characteristics and installation drawings are included.

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more on page 374

## specify... G-E 85C TANTALYTIC\* CAPACITORS

for low-voltage a-c and d-c applications requiring superior performance, small size.

- Dependable operation over a temperature range of -55°C to +85°C.
- Longer shelf life and operating life than previous units.
- Polarized, non-polarized, etched, or plain foil Tantalytic capacitors are available.

SPECIFYING INFORMATION on G-E's complete Tantalytic line is available from your nearest Apparatus Sales Office, or write for GEC-808D, to General Electric, Section 449-12, Schenectady 5, N. Y.

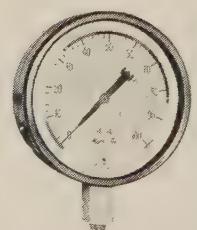
\*Registered Trademark of General Electric Co.

**GENERAL ELECTRIC**

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## New MARSH "Master-Test" SERIES

Twin-tip pointer enables observer to read "dead-on" by lining up twin tips like gun sight.



Mirror dial also insures accurate "dead-on" reading.



"Non-parallax" dial has Plexiglas insert that assures accurate reading even when read at angle.

Conventional dial



MARSH  
"Read-easy"  
dial

New "Read-easy" dial (patent pending), as illustrated above, assures reading accuracy in keeping with indicating accuracy. Also note three advanced means of reading available in all "Master-test" gauges: twin-tip pointer, mirror dial, and "non-parallax" dial as shown opposite.

Sizes 4½", 6", 8". All standard pressure ranges 0-15 psi to 0-30,000 psi, vacuum and compound.

Ask for new 20 page bulletin covering all details

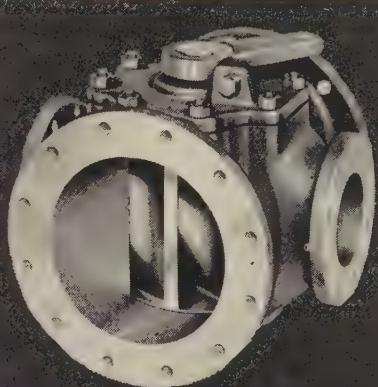
**MARSH INSTRUMENT CO., Dept. 43 Skokie, Ill.**  
Division of Colorado Oil and Gas Corporation  
Marsh Instrument & Valve Co., (Canada) Ltd.  
8407 103rd St., Edmonton, Alberta, Canada  
Houston Branch Plant, 1121 Rothwell St.,  
Sect. 15, Houston, Texas

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SPACE/AERONAUTICS

# NEW

Gorman-Rupp Model 06C-G Pump.  
Self-Priming centrifugal with integral  
power take-off gear box. Newest of  
famous "O" Series line.



# NEW

Unique FDF Fueling-Defueling valve  
to simplify fueling equipment design,  
reduce weight, cut costs.

# NEW

Highly efficient eductor for systems  
using the eductor defueling principle.



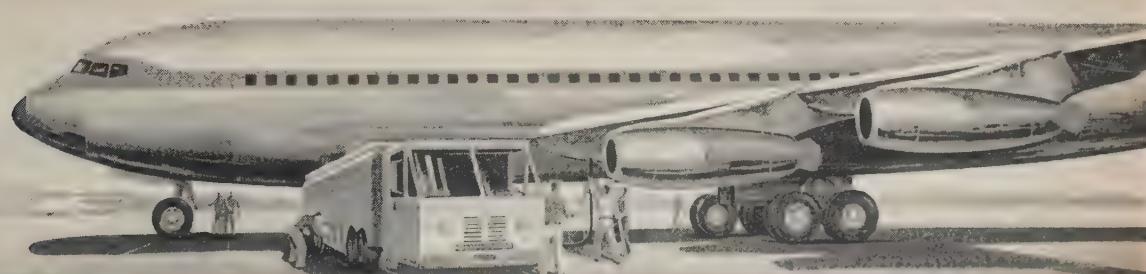
# GORMAN-RUPP FUEL HANDLING EQUIPMENT *for faster, easier fueling and defueling*

Sales literature • Engineering information available • Factory inquiries invited

**THE GORMAN-RUPP COMPANY**

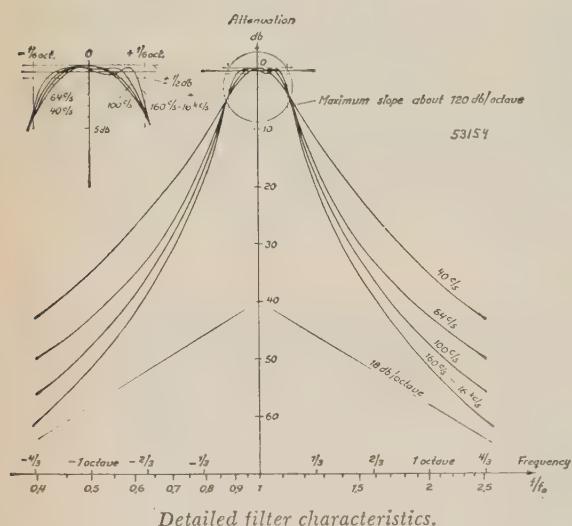
305 Bowman Street

Mansfield, Ohio



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# New . . . Brüel & Kjaer $\frac{1}{3}$ Octave SPECTRUM ANALYZER



- \* Analyzes Noise and Vibration in True RMS Values!
- \* Analyzes Complex Signals—14 c/s to 36,000 c/s.
- \* Analyzes Signals from 5 Micro Volts to 1000 Volts.
- \* Combines with the B & K Level Recorder for Automatic Analysis and Data Plotting.

The new Audio Frequency Spectrometer Model 2110 features switch selection for either a true RMS, average or peak reading of analyzed data. The RMS indication is most frequently preferred for noise and vibration measurements because of its direct relation to the energy of the signal being measured.

The new model 2110 has thirty  $\frac{1}{3}$  octave band filters to extend the frequency range for complex signal analysis to be from 35 c/s to 36,000 c/s. Optional  $\frac{1}{3}$  octave filters may be added to extend the low frequency range down to 14 c/s. The spectrometer can be mechanically switched by the level recorder Model 2304 for automatic measurement and recording of spectrograms on frequency-amplitude calibrated chart paper.

Gentlemen:  
Please send me  
 Information on B & K Model 2110.  
 B & K Complete Line Catalog.

NAME \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_

Exclusive Franchised U.S. Marketing Agent for  
Brüel & Kjaer Instruments



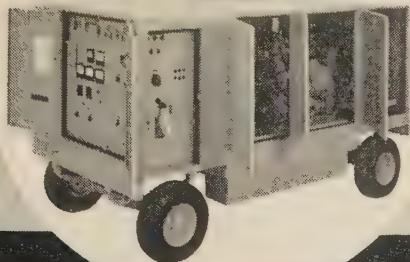
**B & K INSTRUMENTS, Inc.**

3040 W. 106th STREET • CLEVELAND 11, OHIO • CLearwater 1-8430

Write in No. 260 on Reader Service Card at start of Product Preview Section

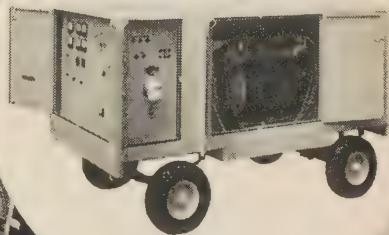
SPACE/AERONAUTICS

Model EPD-1404  
Portable Generator  
— Diesel Driven



## A FLOW OF RELIABLE POWER

Model EPM-1402  
Portable Generator  
— Motor Driven



WHERE YOU NEED IT... WHEN YOU NEED IT

Model ESM-1403  
Stationary Generator  
— Motor Driven

IN THE MULTIPLE RANGES YOU NEED...

On the production line of leading airframe manufacturers... at U. S. Air Force bases... and on the remote air strips of our global defense network throughout the world... wherever logistics call for a full-range power supply of absolute reliability you can depend on generating equipment by the Electric Machinery & Equipment Division of American Electronics, Inc. to meet the need. Providing complete versatility with maximum reliability, this rugged, mobile high-frequency generating equipment is precision engineered for checkout of the complete electrical systems of the B-58 and the F-106. It is doing an equally exacting job of checkout and support for other aircraft and weapon systems.

**MODEL EPG-2401 SERVICING F-106 (top photo right)  
DELIVERS 8 MULTIPLE VOLTAGES SIMULTANEOUSLY**

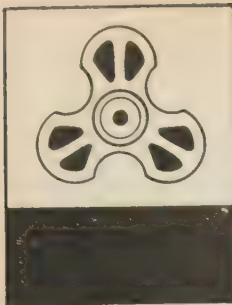
300 volt DC	3.5 amps.
150 volt DC	7.5 amps.
-140 volt DC	4.5 amps.
28 volt DC	75.0 amps.
28 volt DC	100.0 amps.
115/200 volt	400 cycle 20 KVA
115/200 volt	1600 cycle 12 KVA
115/200 volt	400 cycle 5 KVA

*Write for brochure  
detailing full particulars*



**AMERICAN ELECTRONICS, INC.**

ELECTRIC MACHINERY & EQUIPMENT DIVISION  
2112 N. CHICO AVENUE, EL MONTE, CALIFORNIA • TEL. CUMBERLAND 3-7151



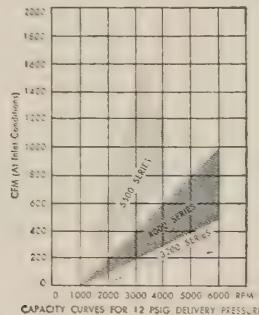
### 3-LOBE DESIGN

Exclusive M-D 3-lobe design adds strength—reduces torsion. Dynamically balanced rotor permits higher speeds—greater pressures.

## Why M-D rotary positive blowers develop higher pressures...

The unique combination of precision manufacture and modern design found only in M-D rotary positive blowers permits higher speed operation and higher pressures. For this reason M-D can furnish greater air flow at lower initial cost.

M-D blowers operate at wider pressure and speed ranges than any other rotary positive blower. Capacities of 22 production models range from 50 to 4,000 CFM, pressures to 14 PSIG single, 70 PSIG multi-stage.



**M-D BLOWERS, INC.**  
RACINE, WISCONSIN



A SUBSIDIARY OF MIEHLE-GOSS-DEXTER, INC.  
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274

### DATA PREVIEW

**RADAR SYSTEM**—A brochure describing the Type WP-101 Airborne Weather Radar System, manufactured by Collins Radio Co., Dept. S/A, 855 35th St. N. E., Cedar Rapids, Iowa, is now available. The system provides the pilot with a continuous map of weather conditions in the general sky area within a radius of 150 miles.

Write in No. 540 on Reader Service Card

**DIGITAL PROCESSOR**—Bulletin 3004 describing the Micro SADIC high speed digital processor is available from Consolidated Electrodynamics Corp., Systems Div., Dept. S/A, 300 N. Sierra Madre Villa, Pasadena, Calif. The booklet gives a general description of the unit applications and complete specifications.

Write in No. 541 on Reader Service Card

**DYNAMOMETERS**—A special design and application booklet, 81 pages, containing typical illustrations of how to make spring testers, measure deflection of aircraft wings, check railroad switches, motor torque, etc., with portable traction dynamometers is available from W. C. Dillon & Co., Inc., Dept. S/A, P.O. Box 3008, 14620 Kiswich St., Van Nuys, Calif. Price: \$0.50.

Write in No. 542 on Reader Service Card

**VIDEO RECORDERS**—A four-page technical brochure describing the specification, operational characteristics and design features of the MINCOM 7-track Video Band Magnetic Recorder/Reproducer, is available from Minnesota Mining and Mfg. Co., Mincom Div., Dept. S/A, 2049 S. Barrington Ave., Los Angeles, Calif. The bulletin includes photographs of actual oscilloscope traces.

Write in No. 543 on Reader Service Card

**TRANSDUCERS**—Bellows-actuated, direct drive and force-rebalance pressure transducers for altitude controls, Mach controls, pressure ratio transmitters, and other aircraft and missile uses have been described in an eight-page pamphlet available from Aeronautical Div., Minneapolis-Honeywell Regulator Co., Dept. S/A, 2600 Ridgeway Rd., Minneapolis 13, Minn. Specifications and modifications are outlined for each of seven basic pressure transducer devices.

Write in No. 544 on Reader Service Card

**INDICATOR TUBES**—A short-form catalog describing components and instruments manufactured by Burroughs Corp., Electronic Tube Div., Dept. S/A, P.O. Box 1226, Plainfield, N.J., is now available. The brochure contains descriptive information and applications data on Burroughs Beam Switching Tubes, Nixie® indicator tubes and visual decoders manufactured by the company.

Write in No. 545 on Reader Service Card

**SERVO VALVES**—Catalog 220, published by Moog Valve Co., Inc., Dept. S/A, Proner Airport, E. Aurora, N.Y., describes the firm's line of flow-control servo valves for use in a wide range of aircraft, missile, nuclear and industrial applications. A glossary of important servo valve terms is also included in this 6½-page, three-color brochure.

Write in No. 546 on Reader Service Card

**RESISTORS**—Catalog Sheet DC-8 has been issued to describe the Multi-Range Resistor line and Multi-Range Kit of International Resistance Co., Dept. S/A, 401 N. Broad St., Philadelphia 8, Pa. The line's five basic units provides 200 fixed resistance values.

Write in No. 547 on Reader Service Card

**CORE FERRITE**—MN-30, a highly machinable, high-permeability ferrite for use in magnetic core has been described in a data sheet available from Kearfott Co., Inc., Dept. S/A, 1500 Main Ave., Clifton, N.J. Low loss and high saturation characteristics permit efficient application at frequencies up to 500 kc.

Write in No. 548 on Reader Service Card

**MISSILE PLUGS**—A description of the latest developments in Cannon umbilical plugs designed for ground testing related to missile launching has been included in a 48-page catalog prepared by Cannon Electric Co., Dept. S/A, 3208 Humboldt St., Los Angeles 31, Calif. "Guided Missile Umbilical Connectors" also contains information on remote release disconnect mechanisms.

Write in No. 549 on Reader Service Card

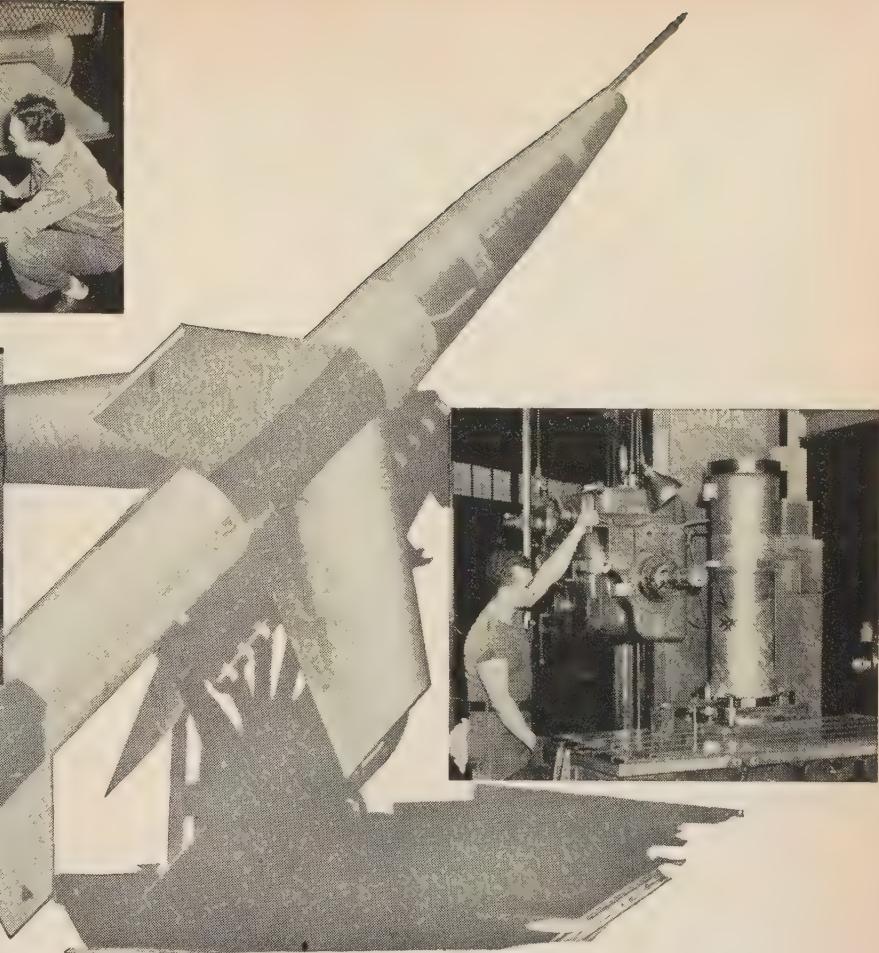
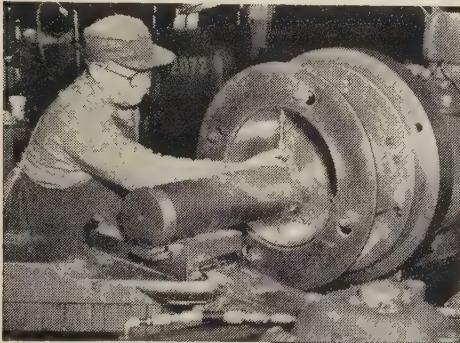
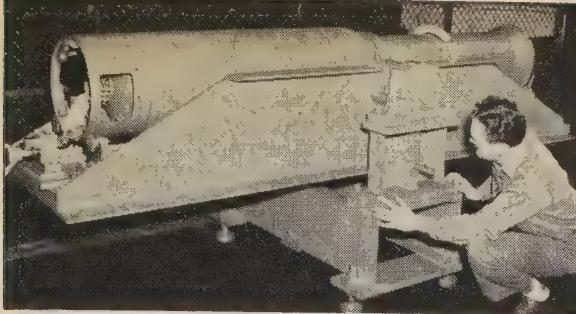
**CONNECTORS**—Its electrical connector facilities and techniques that have led to developments such as the miniature quick-disconnect line and snap-in connectors have been briefly described in eight-page Brochure DE-28 by The Deutsch Co., Dept. S/A, 7000 Avalon Blvd., Los Angeles, Calif. The connectors are used in high-speed aircraft and missiles.

Write in No. 550 on Reader Service Card

**PRECISION CAMS**—A folder that illustrates typical cams and camshafts made for experimental or production purposes has been prepared by Eonic, Inc., Dept. S/A, 462 E. Hollywood, Detroit 3, Mich. Precision components have been made for aircraft engines and landing gear, computer use, duplicating machine masters, and a variety of other applications in the aircraft and other industries.

Write in No. 551 on Reader Service Card  
**more on page 378**

SPACE/AERONAUTICS



## Missiles destined to be on target are built with PARISH precision

The U.S. Army's missile . . . La Crosse . . . is designed to kill in a single shot. That's why Martin engineers insist on the most rigorous specifications and why Parish was selected as subcontractor for the engine metal parts assembly.

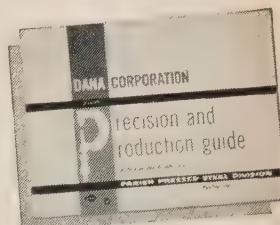
Precision . . . for absolutely controlled flight . . . is built into every part of the Parish assembly. Balance is critical and the weight of the entire assembly cannot vary more than  $\frac{1}{4}$  of 1% of design weight. Add another factor . . . complete interchangeability . . . and you'll

see why Parish is one of the select few subcontractors regularly mass producing for the missile industry.

Parish has the experienced men and the precision tools for still another missile contract. Why not insure performance by calling Parish today?

### WRITE TODAY . . .

For free booklet describing Parish facilities and equipment that can help cut costs for you.

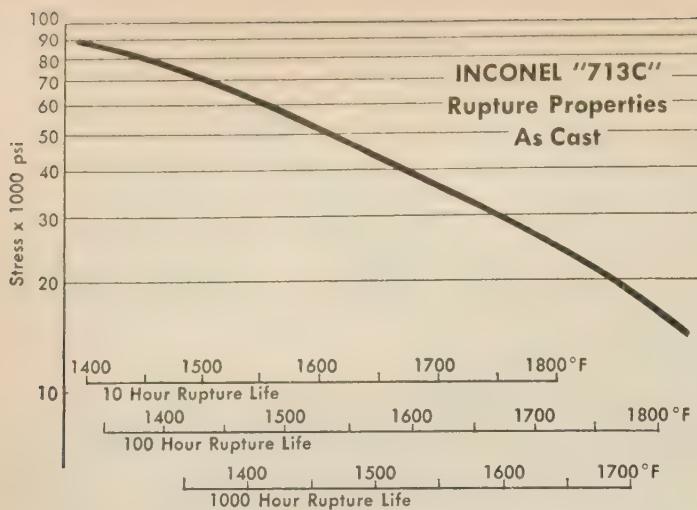


● DANA PRODUCTS: Transmissions • Universal Joints • Propeller Shafts • Axles • Torque Converters • Gear Boxes • Power Take-offs • Power Take-off Joints • Rail Car Drives • Railway Generator Drives • Stampings • Spicer and Auburn Clutches • Parish Frames • Spicer Frames • Forgings

**DANA** **PARISH** **PRESSED STEEL**

Division of Dana Corporation / Reading, Penna.

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Graph shows the 10-hour, 100-hour and 1000-hour rupture strength that Inconel "713C" provides at 1700°F

## New cast alloy! New rupture strength!

Now aircraft and missile designers have a new alloy to work with:— Inconel "713C"\*\* nickel-chromium cast alloy.

It was developed especially for high temperature investment cast parts in advanced jet aircraft and missile hardware.

Basically, Inconel "713C" alloy combines outstanding rupture strength at 1700°F (see graph) with excellent resistance to thermal fatigue and good castability.

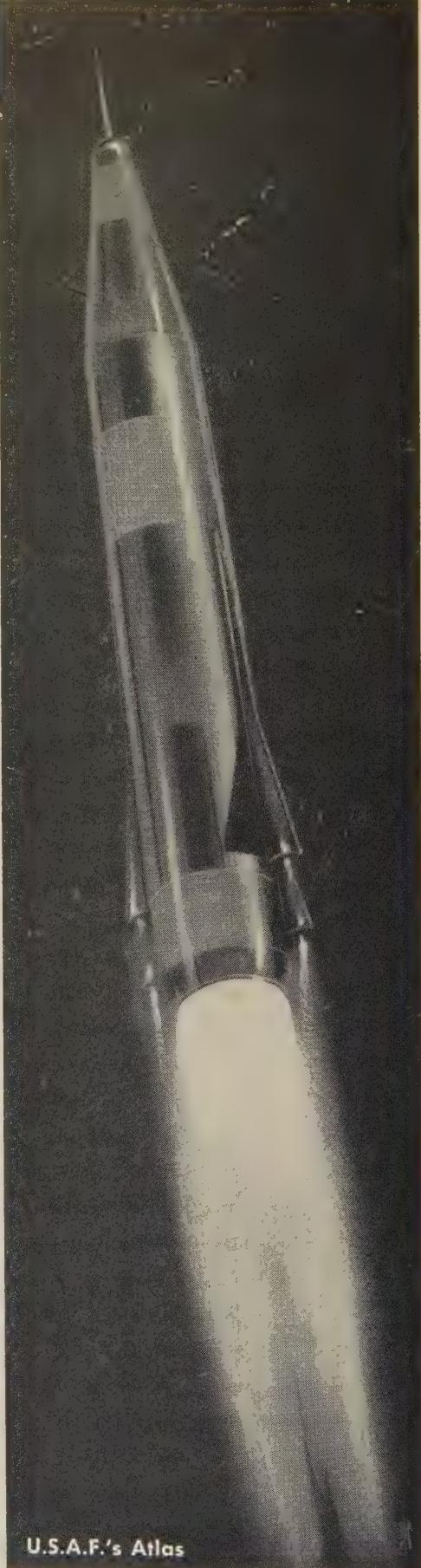
### Other new high temperature alloys

In addition to Inconel "713C", a number of other new high temperature alloys have been developed which may well be the answer to material-selection problems in missile design. They include: Incoloy "T" titanium-containing nickel-iron-chromium alloy, Incoloy "901"\*\* nickel-iron-chromium alloy, Inconel "700"\*\* age-hardenable nickel-cobalt-chromium alloy and Inconel "702"\*\* aluminum-containing nickel-chromium alloy. For comprehensive data on these new nickel alloys, write to:

\*Inco trademark

### HUNTINGTON ALLOY PRODUCTS DIVISION

The International Nickel Company, Inc.  
67 Wall Street      New York 5, N. Y.



U.S.A.F.'s Atlas

# INCONEL "713C"

Write in No. 264 on Reader Service Card at start of Product Preview Section

**Ionosphere, Troposphere, Everywhere**

## **Honeywell Tape Systems**

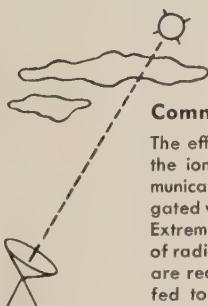
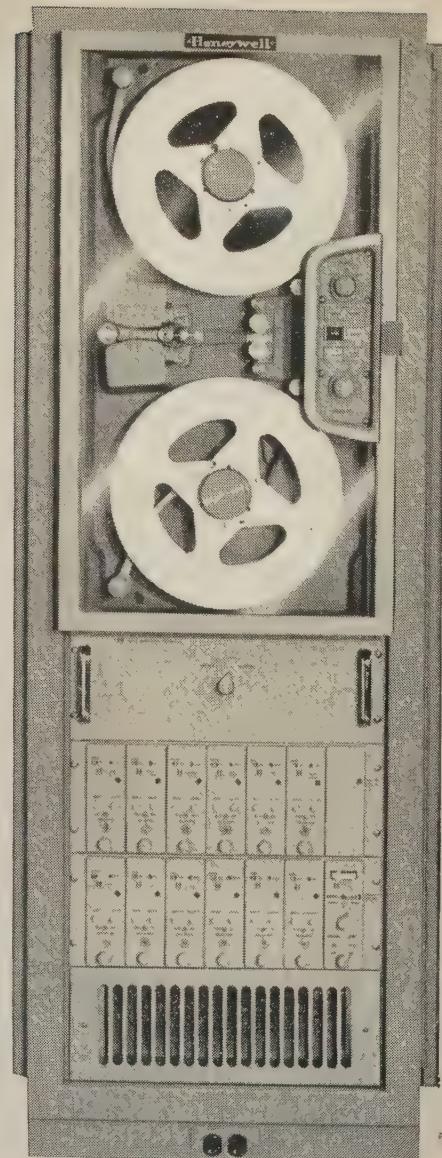
**win acceptance for  
the tough recording jobs**

Wherever accurate collection of high speed data is required . . . from monitoring space signals and testing jet engines to studying submarine vibrations . . . Honeywell Magnetic Tape Systems are handling the jobs quickly and economically.

With Honeywell's exclusive wide tapes, these systems record as many as 40 tracks on one tape . . . preserve massive amounts of data with minimum original equipment cost. Other mechanical and electronic features insure dependable performance . . . easy operation.

For the full story on a system tailored to your needs, just give your Honeywell field engineer a call.

**MINNEAPOLIS-HONEYWELL, 10721 Hanna Street,  
Beltsville, Md.**



### **Communications Studies**

The effect of electron clouds in the ionosphere on radio communications is being investigated with a Honeywell System. Extremely accurate recordings of radio signals from a satellite are recorded, edited and then fed to a computer for rapid analysis.



### **Jet Engine Testing**

Stress, vibration, fuel and air pressure and critical temperatures of jet engines are all recorded simultaneously on one 1 3/4" tape. The Honeywell System's high capacity and unique transport switching panel make it possible to record entire test with no interruptions.



### **Tropospheric Studies**

Tropospheric scatter propagation studies determine power spectrum amplitude distribution and median signal level with a Honeywell System. Simplified speed control makes it easy to reduce playback speed for more accurate analysis.

# **Honeywell**



***First in Control***

**Write in No. 265 on Reader Service Card at start of Product Preview Section**

# IT'S THE FINISH THAT COUNTS



## IN TUBING TOO!

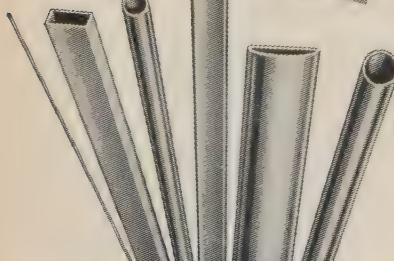
### TESTS PROVE PRECISION FINISH UNSURPASSED

Shape, size, alloy are important in tubing and Precision Tubing excels in all . . . but finish is an outstanding quality of Precision Tubing where specified . . . and at no extra cost.

Precision Tubing is available in clean, scratch-free finishes suitable for anodizing or plating to mirror finishes. In sizes from .010" to 1.125" O.D. in copper, brass, aluminum, up to  $\frac{3}{8}$ " O.D. in nickel and nickel alloys.

Other Precision Tubing is available in straight lengths, coils, preformed to specified shapes . . . and also as Coaxitube the metal shielded coaxial conductor. Whatever your designs or requirements for fine accurate tubing at regular tube prices order Precision Tubing. Write for complete technical data to Dept. 10, Precision Tube Company, Inc., North Wales, Pa.

GET THIS NEW TUBING DATA CATALOG . . .  
FREE!



**PRECISION  
TUBE  
COMPANY**

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### DATA PREVIEW

**PRECISION COMPONENTS**—A four-page brochure has been issued to describe a line of precision components for computers, instruments, and control systems made by Ford Instrument Co., Dept. S/A, 31-10 Thomson Ave., Long Island City 1, N.Y. Specifications and performance data are included for cams, synchros, mechanical differentials, oldham couplings, and ten-W low-inertia servo motors

Write in No. 552 on Reader Service Card

**CONNECTORS**—A comprehensive, 24-page printed circuit connector catalog, PC600-359, which lists connectors accommodating  $\frac{1}{16}$ ,  $\frac{3}{32}$ - or  $\frac{1}{8}$ -in. printed circuit cards, has been issued by DeJur-Amsco Corp., Dept. S/A, 45-01 Northern Blvd., Long Island City 1, N.Y. Up to 116 contacts are available in one molding, and various wiring styles and molding compounds may be specified.

Write in No. 553 on Reader Service Card

**LOGIC UNIT BOARD**—A transistorized digital component from which computers and data handling systems can be constructed simply and at low cost has been described in a technical bulletin available from Mechanical Div., General Mills, 1620 Central Ave., Minneapolis 13, Minn. The Logic Unit Board contains 24 logic units.

Write in No. 554 on Reader Service Card

**HYDRAULIC TESTING**—Technical Bulletin 1373, a two-page release on a portable, self-contained, hydraulic test cart for missile field test procedures is available from George L. Nankervis Co., Dept. S/A, 15400 Fullerton Ave., Detroit 27, Mich. The Model 9462 carts, mounted on four-wheel axles, supply ten-gpm of clean, tempered oil at up to 3000 psi.

Write in No. 555 on Reader Service Card

**SYSTEM ERROR BRIDGE**—A four-page bulletin on the system error bridge, a device capable of measuring outputs of synchros and resolvers sealed in a system, has been published by Theta Instrument Corp., Dept. S/A, 48 Pine St., East Paterson, N.J. The device can be used to determine antenna position, measure the tilt of an inertial, stable platform, and simulate a synchro or resolver input to a system.

Write in No. 556 on Reader Service Card

**SURFACE COATING**—Buletin 67, a data sheet on an easily removable protective coating for metallic and non-metallic surfaces, is available from Turco Products, Inc., Dept. S/A, 6135 S. Central Ave., Los Angeles 1, Calif. Fabrifilm is reported to offer advantages of zinc chromate primer without the difficulties of removal, and it is designed especially for use during in-plant processing operations.

Write in No. 557 on Reader Service Card

**BEARINGS**—A technical report on spherical bearing tests, including charts, tables, and diagrams, has been issued by F. A. B. Mfg. Co., Dept. S/A, 1249-67 St., Oakland 8, Calif.

Write in No. 558 on Reader Service Card

**VIBRATION TESTER**—A technical data release describes a new lateral controlled motion vibration tester, as featuring a horizontal, air supported push-pull driven table. It is available from L. C. Miller Co., Dept. S/A, Los Angeles 22, Calif.

Write in No. 559 on Reader Service Card

**CRYOGENICS**—Kelvin Scale, a news sheet of current information on cryogenics and related subjects, is offered by Arthur D. Little, Inc., Dept. S/A, 20 Acorn Park, Cambridge, Mass.

Write in No. 560 on Reader Service Card

**SERVO AMPLIFIER**—A data sheet on a transistorized, lightweight, RMI servo amplifier for driving an additional RMI card has been issued by Collins Radio Co., Dept. S/A, Cedar Rapids, Ia. The Model 341C-1 amplifies the 400-cps error voltage signal from the control transformer in the 332C-1 or equivalent radio magnetic indicator to a level sufficient to drive the compass control motor.

Write in No. 561 on Reader Service Card

**AIRBORNE RECORDER**—Complete information on the AR-200 airborne magnetic tape recorder is contained in a 12-page brochure issued by Ampex Corp., Dept. S/A, 934 Charter St., Redwood City, Calif. The modular, miniaturized unit is designed for application in modern airborne data acquisition.

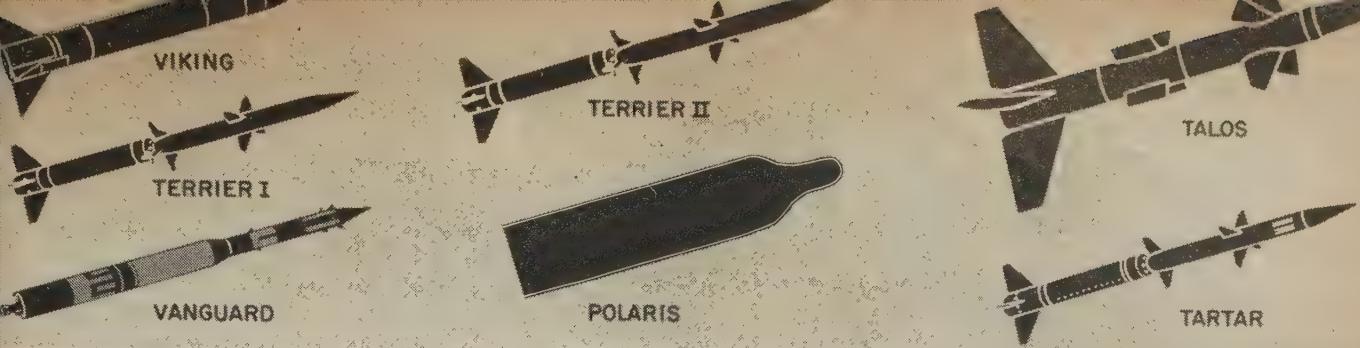
Write in No. 562 on Reader Service Card

**ALTERNATOR SETS**—High performance, statically controlled 400-cycle motor-alternator sets up to 5 KVA 3 phase output are described in Bulletin GET-2906 by General Electric Co., Dept. S/A, Schenectady 5, N.Y. The illustrated publication includes schematic system diagrams, pictures and outline dimensions.

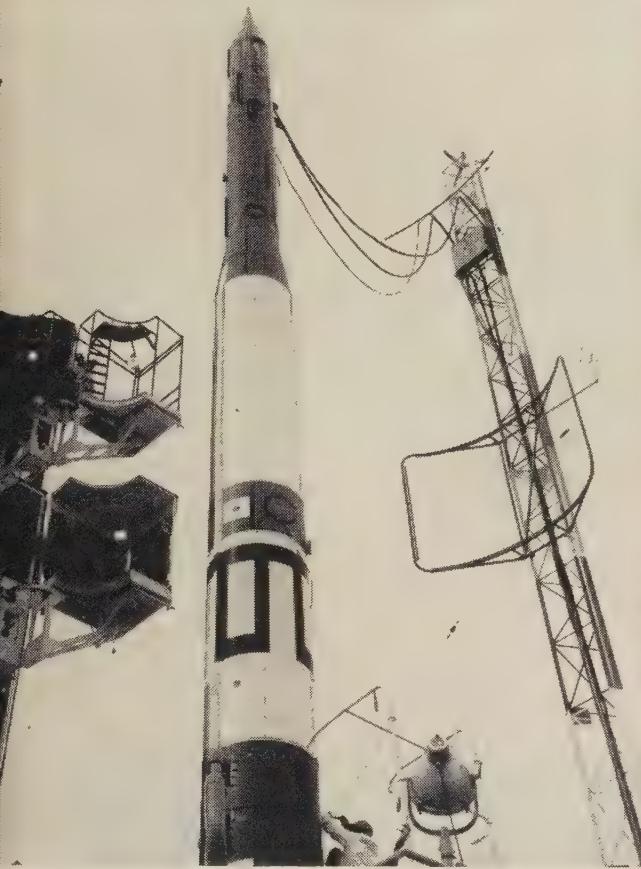
Write in No. 563 on Reader Service Card

**DIP BRAZING**—Details of the application of aluminum dip brazing techniques to aircraft engine component manufacture have been summarized in a four-page folder issued by Hamilton Div., Bendix Aviation Corp., Dept. S/A, Fifth St. and Ford Blvd., Hamilton, O. Advantages of the technique in the design of fuel flow dividers, main engine controls, pumps, and other devices include lighter weight, smaller size, and lower cost.

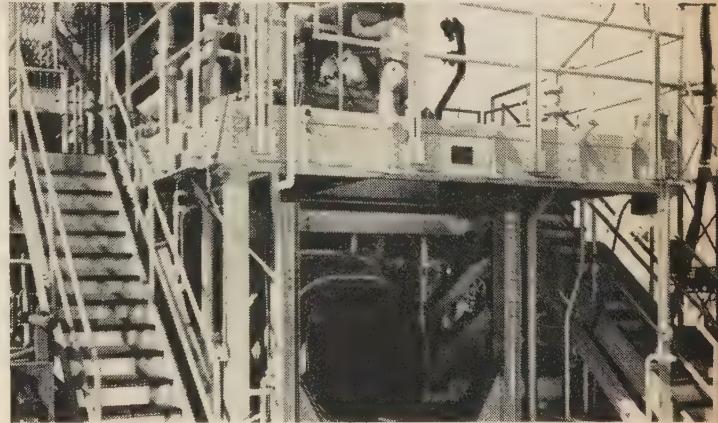
Write in No. 564 on Reader Service Card



Loewy-Hydropress has been engaged in building handling, stowage and launching systems for these rockets and missiles.



Vanguard rocket being readied for launching on March 17, 1958.



Testing and firing installation for Viking and Vanguard rockets.



Ship motion simulator for test-firing U.S. Navy's guided missile "Polaris" under seagoing conditions.

## Loewy ground handling and launching systems in successful operation and in progress

Giant and unusual facilities for handling, testing and launching missiles and rockets have been built and put in operation by Loewy-Hydropress for the U.S. Navy's Fleet Ballistic Program and for the joint IGY Program of the Navy and the National Academy of Science. These installations have proven their brilliant effectiveness under the most trying circumstances.

Loewy-Hydropress has also been chosen to design systems for the protection, handling and launching of surface-to-air supersonic missiles and missile components for the Navy's first nuclear-powered cruiser, *Long Beach*.

Another Loewy system is in development for supersonic missiles which will be installed on Navy aircraft carriers.

Loewy engineers build all kinds of handling, stowage and launching facilities for guided rockets and missiles of various sizes and operating ranges.

They also specialize in the design and construction of radio telescopes and related space communication systems.

Avail yourself of the experience and ingenuity of the Loewy organization, which coordinates all other B-L-H divisions that are actively engaged in the specialized fields. Just write us at Dept. R-10.

### Loewy-Hydropress Division

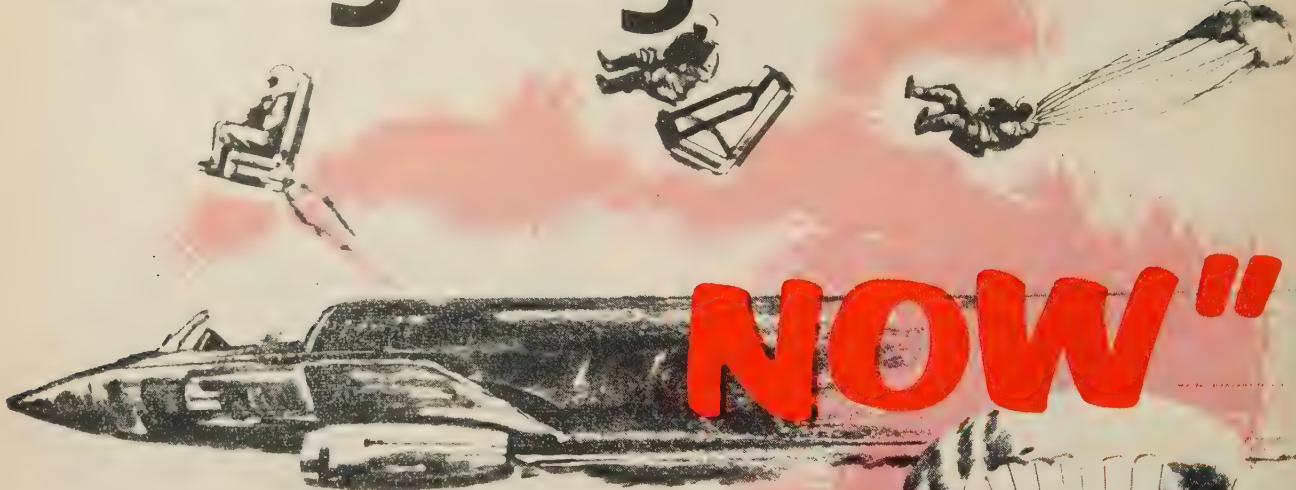
BALDWIN · LIMA · HAMILTON

111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

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# "Mayday...leaving



*He'll be flying*

**TOMORROW...**

*thanks to*

**TEAMWORK**

**PROBLEM:** Get the man-seat out of the plane...get the man out of the seat...get the man safely to the ground.

**SOLUTION:** The Talco Rocket Catapult, the Talco Man-Seat Separation Actuator, and the Automatic Parachute System.

Tested by Lockheed for the upward ejection system on their F104 aircraft, and further tested by the Air Force, the Talco Rocket Catapult and Man-Seat Separation Rotary Actuator have proven to be the most effective method yet devised for safe ejection at slow speeds from ground level, as well as high speeds at altitudes.

Lockheed engineers devised a strap system for man-seat separation, then called upon Talco to furnish the actuating power. For this system, a web strap arrangement is attached to the seat bucket lip, running beneath the survival kit and up behind the parachute pack into the Talco Rotary Actuator in the head rest. One second after ejection, the lap belt is automatically released and the Talco Rotary Actuator is initiated so that the webbing is wound taut between the head rest and the bucket lip. This action forcibly separates the man from his seat, automatically actuating the parachute release mechanism.

Talco engineers do their best work on projects like this one...projects where there can be no margin for error. Firms like Lockheed have come to rely on Talco. You can, too. Write today for complete information.

# Talco

**Gabriel**

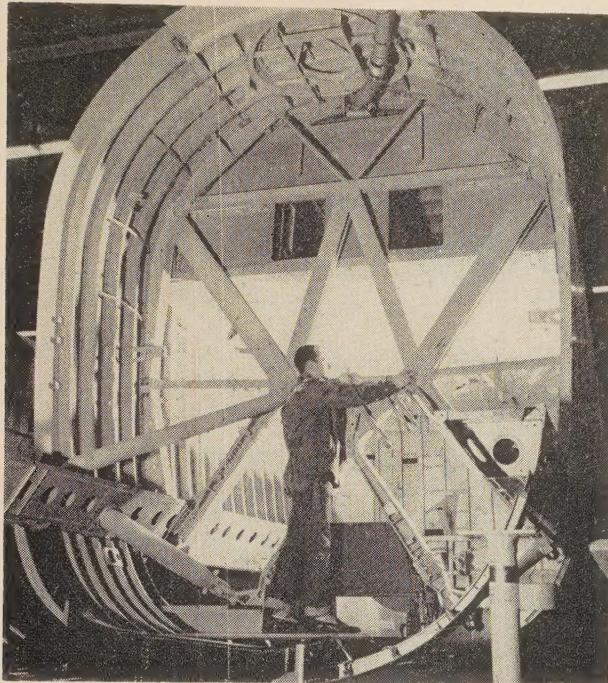
The Talco Engineering Company  
Falcon Field • Mesa, Arizona

Talco Engineering • Subsidiary/ The Gabriel Company

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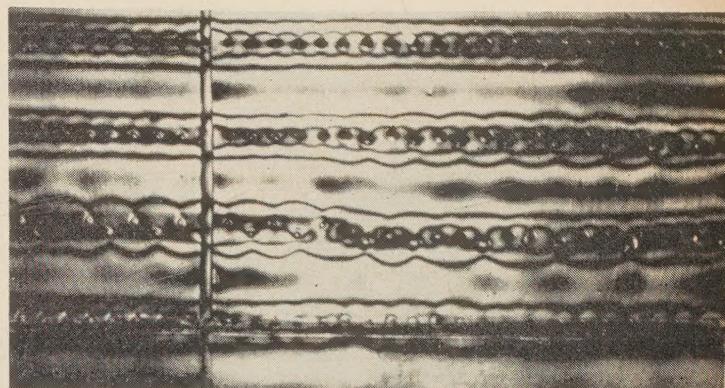
SPACE/AERONAUTICS

## industry briefs

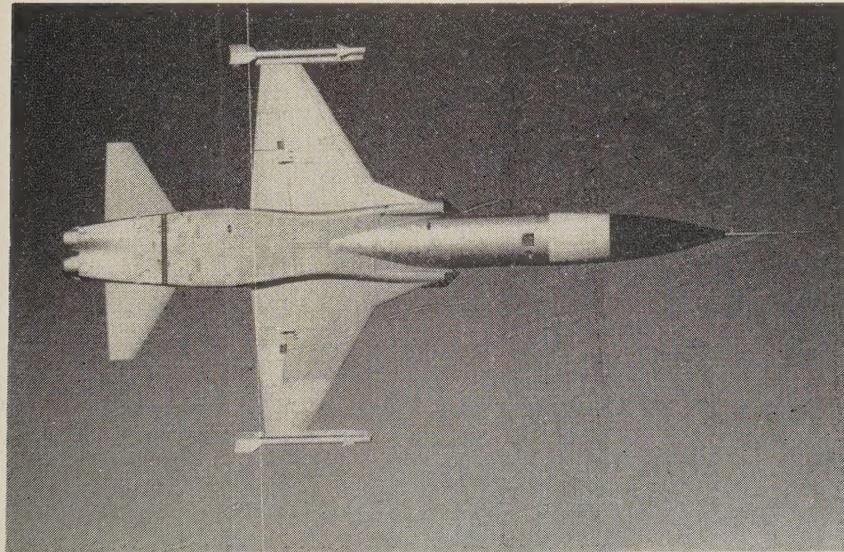


**INNARDS OF** Boeing B-52G are revealed in this shot of a forward landing gear bulkhead (whose top forms a large "W"). Made by H & B Machine almost entirely of forgings, the assembly also serves as a fuselage support. It weighs more than 1000 lb and measures about 12x14 ft.

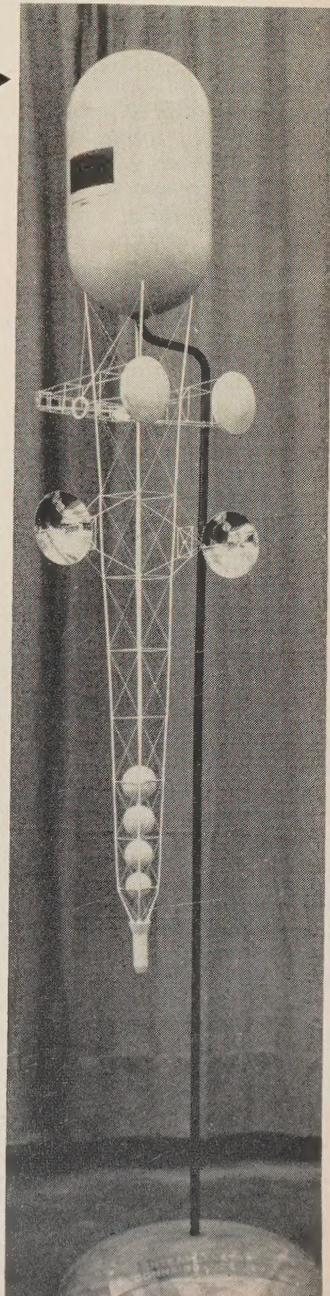
**STRESS DISTRIBUTIONS** (dark lines) around spot welds in Convair 880 wing are made visible by PhotoStress, produced by Tatnall Measuring Systems. A birefringent plastic, it is bonded to the structure under stress analysis.



"**SIMPLER** and cheaper in construction than any other orbital station now being considered" is Boeing's claim for this design for a manned interplanetary reconnaissance vehicle. The 20x74-ft craft would be assembled in orbit.



**IN AIR DEFENSE** configuration, Northrop's N-156F shows off two Sidewinder air-to-air missiles as it goes through a slow roll. Belonging to the same family as the T-38 trainer, the "counterair" fighter was designed with an eye to the needs of our NATO and SEATO allies, in whose countries most of the N-156Fs will actually be produced. Suitable for both intercept and bombing missions, the operational plane will fly at Mach 2.





## readers' round table

### The cost of survival

by John A. Marshall

Senior Manufacturing Engineer\*

THE RACE for space supremacy between us and the Reds will force the U.S. to make a major economic reappraisal in the next decade. An analysis of space control cost that must be attained has not been made. It will stagger government and industry leaders.

The high costs of the project are caused by lack of knowledge needed to develop the needed materials and new production methods. These requirements exceed present capabilities of equipment, facilities, and trained personnel. Economists, scientists, and engineers will have to plan parallel courses to meet the time requirements.

There are two courses open to pay for the needed production and R&D advances:

- government deficit financing,
- increase of the gross national product.

The latter is the obvious choice. But to do the job, the GNP will have to double at least its current level by exceeding \$1000 billion. To get this figure, large corporations must grow, and new ones must be formed, to the point where a revision of the anti-trust acts will be required.

Revision of these acts would make other regulatory laws needed. These would be based on a new philosophy of corporation control. This change would be extreme to where a moratorium on profit distribution would be decreed and capital growth would be specified.

Achievement of this GNP figure by 1970 is our cost of survival. The price for space projects alone will top \$15 billion a year. Unhappily, our economic system now couldn't support this spending along with the other federal budget items. Therefore, our system must gear itself to a more controlled economy.

The Soviet foreign policy is based partly on the breakdown of our economic system. This is predicted through federal deficit financing for space projects of extreme size. In this the Reds are banking on the U.S. public's immovable resistance to large corporate growth. Even some of our economists fail to see the changes that will be needed in our system.

Others, recently returned from the Soviet Union, have noted that economists there have influenced the Politburo into allowing some departures from Marxist economic theories. These changes have resulted in an alarming internal economic growth behind the Iron Curtain. It may be the Reds' first step in blocking the

U.S. economy from support of space development projects.

The foremost requirements for spacecraft, rocket engines, and electronics are in astronautics and ordnance. Because of extreme thrust values, basic materials conditioned to withstand greater stresses are needed. Metallurgists and design groups are faced with problems in nuclear properties, thermal conductivity, erosion resistance, creep properties, ease of production, and costs that far exceed the same problems in the past ten years. Lack of adequate materials represents a void in engineering and contributes to limits in production capabilities.

In the past, production methods and medical cures have followed long periods of R&D projects, and their cost has been minimized by time. Now we are faced by a compounded engineering and economic situation: R&D and production must go along hand in hand. Thus we find staggering R&D and production costs to be absorbed in the current economy, and we decry these costs, which occur not only today but are predicted to be larger in the future.

This spending is necessary to develop three basic types of permanent manned satellites: scientific, observation, and ordnance. Stationary satellites to emerge from technological advances will travel at 6500 mph and 22,000 miles altitude. They will be able to remain in a fixed position over a preselected location. They will be manned, and medical problems will be equally great as the engineering. These will range from distillation of urine and wash water for human use, solidification of human waste, closed-cycle breathing and ventilation systems, to weightlessness, psychological weakness in sealed cabins, and the maximum g-forces people can withstand.

Today we face a situation where we must accept the ideology of "survival at any cost." For who is to set the price for maintaining our form of government? As sure as we are here today, if our enemy puts manned permanent satellites into space first, we shall have the sword of Damocles over our heads.

The heritage we have enjoyed by our birthright must now be paid for in dollars. We must build a national defense conceived by R&D of scientific and military capabilities and dedicated to the freedom of man.

Our freedom no longer can be a free ride.

Contributions to this department may be on any subject, technical or nontechnical, about which readers would like to air their views. Names and professional affiliations will be withheld on request.

\*Mr. Marshall is associated with a major missile manufacturer.



## Now... Hot Gas to impart force or motion

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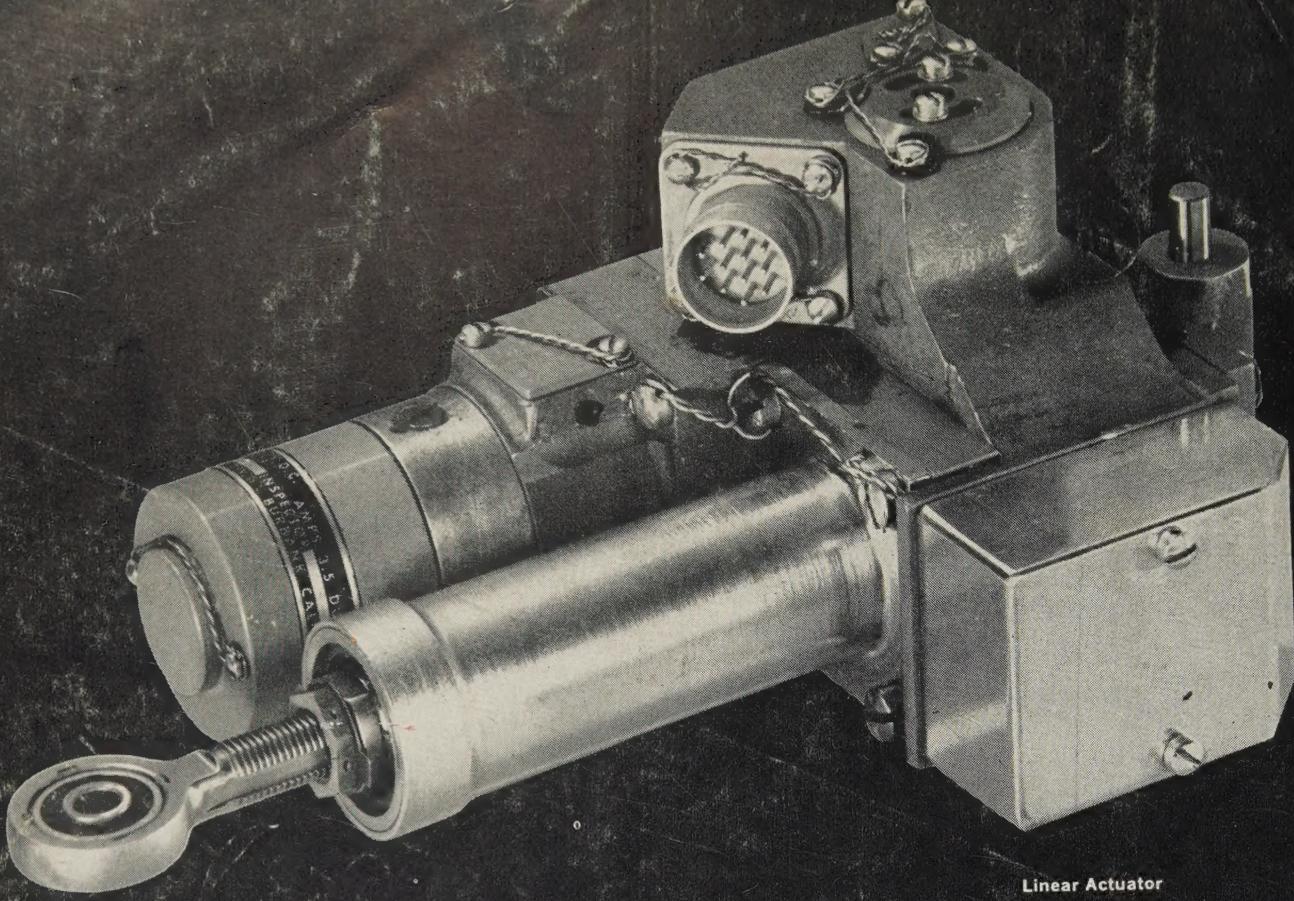
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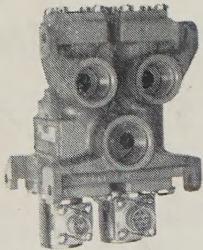
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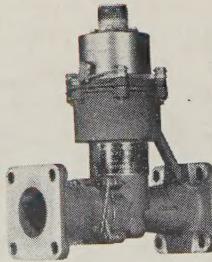


Linear Actuator

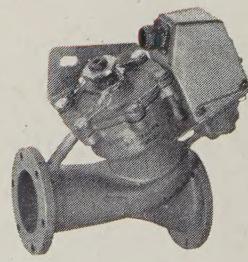
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